THE EFFECT OF THREE-DIMENSIONAL GRAPHS ON DECISION MAKING

THESIS

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THESIS

Presented to the Faculty of the Graduate School of Logistics and
Acquisition Management of the Air Force Institute of Technology
Air University
in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Systems Management

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Preface

The objective of this thesis was to determine whether or not, and by how much, three-dimensional graphs are more accurate and efficient than two-dimensional graphs and tables when presenting alternatives to decision makers.

A graphical experiment was designed using a microcomputer. This experiment presented a business scenario to test Air Force Institute of Technology (AFIT) Professional Continuing Education (PCE) students. The experiment attempted to determine how well DoD decision makers accurately and efficiently performed elementary data collection tasks using various graphs or tables.

The experiment used a randomized order within-subject factorial design with repeated measures. The factorial experiment was designed to analyze the manipulation of three factors or independent variables, anchoring, mode of presentation, and data-set, to determine their effects on the response variables of degree of accuracy, and response time (efficiency).

The results of the accuracy analysis showed that in general, accuracy performance was high for most subjects regardless of the mode of presentation or the task anchoring. The timed response analysis showed that it took subjects longer to interpret three-dimensional line graphs and three-dimensional bar charts for two of the elementary data collection tasks.

We would like to thank the PCE instructors and students for allowing us to use their classes during experiment. We'd also like to thank the Graduate Systems Management Class (94S) for participating in the pilot testing.

We would also like to thank our thesis advisor, Dr. David Christensen for his help in providing a thesis topic and his insights into the world of research. In addition, we would like to thank Professor Dan Reynolds for his enthusiasm and support of this effort.

Finally, we'd like to thank our beloved spouses for their love and support!

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Abstract

A randomized order within-subject factorial design with repeated measures experiment was conducted to assess how well DoD decision makers accurately and efficiently performed elementary data collection tasks using various graphs or tables.

The factorial experiment was designed to analyze the manipulation of three factors or independent variables, anchoring, mode of presentation, and data-set to determine their effects on the response variables of degree of accuracy, and response time (efficiency). In this experiment five treatment levels were selected for mode of presentation: table, two-dimensional bar, two-dimensional line, three-dimensional bar, and three-dimensional line. Four treatment levels were selected for task anchoring: high x, high y; high x, low y; low x, high y; and low x, low y value anchoring. The third factor, data-set combination, used two unique dats-set treatment levels.

Data extraction accuracy was not significantly affected by presentation format. The timed response analysis showed that for the high-high anchoring questions three-dimensional line graphs took the longest to interpret. There were mixed results for the high-low anchoring questions. The bar charts were expected to be interpreted faster; however, the three-dimensional bar chart took the longest to interpret. All of the modes of presentations were interpreted relatively the same for the low-high anchoring questions. The line graphs were expected to be the fastest; however, the results of this study showed no difference. Subjects interpreting the line graphs spent less time performing low-low anchoring questions, than they did interpreting the other modes of presentation. Overall, the analysis could not detetermine that there were any elementary data collection tasks in which three-dimensional graphs facilitated more accurate and efficient solutions than two-dimensional graphs and tables.

THE EFFECT OF THREE-DIMENSIONAL GRAPHS ON DECISION-MAKING

I. Introduction

General Issue

The underlying purpose of using graphics can be found in the old adage, "A picture is worth a thousand words." A graphical image has the ability to summarize complex relationships among large quantities of data into an easily understood trend. This makes a graph an effective tool for influencing our perception of the relationships that exist in the data being portrayed. It also makes a graph extremely useful in the decision-making process. Advanced computer graphics packages have become powerful and essential tools in communicating information to decision makers. Computer graphics, especially in business, have become an important element in the presentation of information either internally or to the public.

How a person presents his or her ideas is critical in the decision -making process. According to Needleman, "Regardless of whom you are making a presentation to, the purpose of a presentation isn't to make your point, but to sell an audience on your point of view!" (15:15). Using graphics is an effective method to communicate those ideas, and it enhances the chance of success. The success or failure of an individual's presentation hinges on two factors: how convincing the presentation is, and how accurately decision makers interpret the graph. "You not only have to understand what information you need to present, but also the best way to present it so that it reinforces your final goal, not obscures it" (15:15). The presenter must select an appropriate graphical format that will capture the audience's attention and enable the audience to make an accurate decision.

Specific Problem

Statements such as graphics lead to more effective analysis and decision making; graphics help users to find problems; graphs make tasks less difficult; and graphics make presentations more convincing, are typical claims graphics vendors make to sell their products. Some researchers claim these statements are myths, and other researchers acknowledge they just do not know (12:1). During a two-year study, a University of Minnesota research team investigated the effectiveness of using business graphics (12:1). The team presented five key findings in the study: graphic use will increase in the future, graphics will find their greatest use in decision support and communication, there is a learning effect with graphs, the superiority of graphs over tables is not supported, and there is a great opportunity for misuse of graphics (12:4).

Although the Department of Defense (DoD) is a non-profit organization and is not considered a corporation or business, it is an organization where essential decisions must be made by managers at all levels of government. Communication and the transfer of necessary information is critical to our national defense. The data presented to managers is often in the form of graphics to help facilitate decision making and consolidate enormous quantities of data. Since DoD has a centralized decision making style, and the decisions made by lower level managers impact higher level managers decisions, it is absolutely essential information is portrayed accurately. The results attained from graphics research will legitimately aid decision makers in understanding data formulation. The research will help managers understand issues such as graph characteristics, which modes of presentation are most suitable for a given task question, which modes of presentation have the lowest comprehension, and which modes of presentation are the most time consuming. If DoD managers are educated on the effect of ill-prepared graphics, and how these graphs can misrepresent data, they will be given the tools to become even better decision makers.

In the past, researchers have focused a significant amount of attention on the effects of graphical format on decision making. However, researchers have neglected to examine the effects of three-dimensional graphs on decision making accuracy as well as the efficiency of three-dimensional graphs. Accuracy is defined as the correct response given to a particular scenario or task, and efficiency is described as the timeliness of making this decision associated with the given mode of presentation. Thus, the objective of this thesis is to determine whether or not, and by how much, three-dimensional graphs are more accurate and efficient than two-dimensional graphs and tables when presenting alternatives to decision makers. For the purpose of this study, the two-dimensional graphs (Figure 1) display data plotted using only a horizontal and vertical scale (x-axis, y-axis). Three-dimensional graphs (Figure 2) also display data plotted using a horizontal and vertical scale; however, these graphs add only an aesthetic third dimension that provides a depth perception (i.e. no values are plotted using the z-axis).

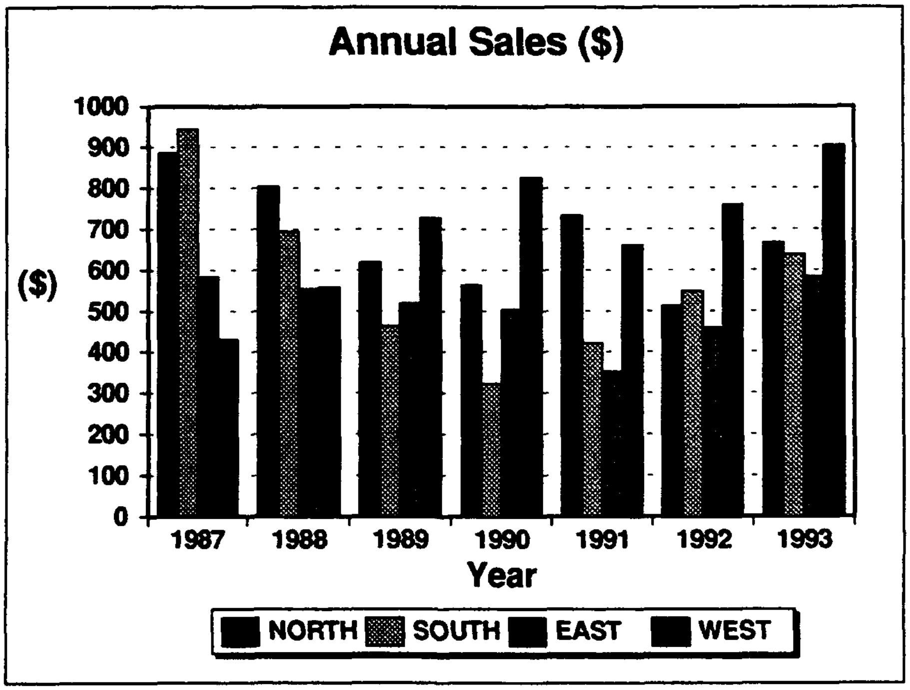


Figure 1. Two-Dimensional Graph Example.

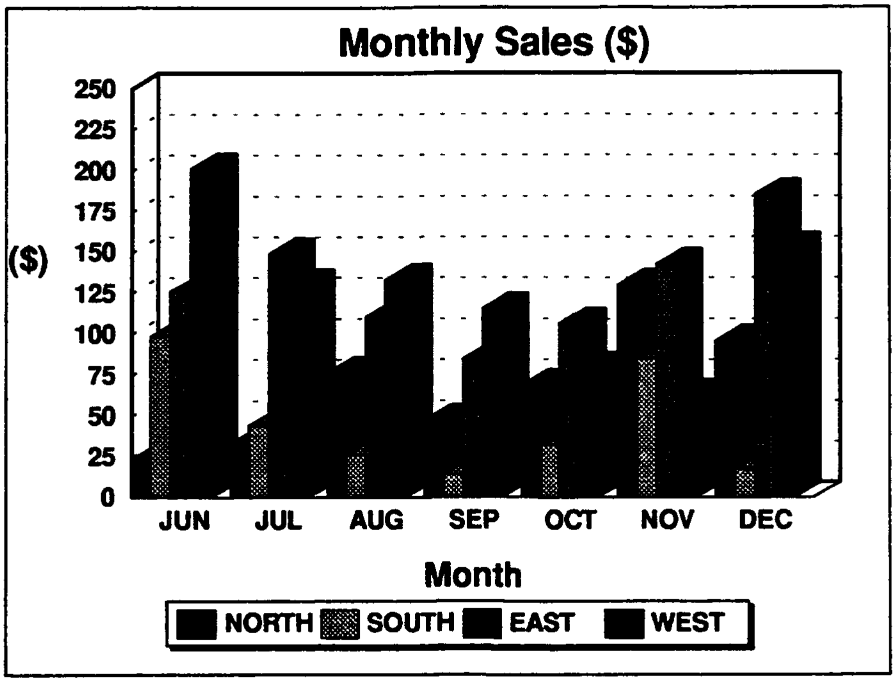


Figure 2. Three-Dimensional Graph Example.

Investigative Questions

The following investigative questions need to be addressed to achieve the objective of this thesis:

1. How extensively are computer generated graphics used in business today?

2. What are the standard criteria used when formatting graphics to avoid misleading graphics?

3. Do various modes of graphical presentation affect the accuracy associated with given elementary data extraction tasks?

4. How efficient are the various modes of graphical presentation associated with given elementary data extraction tasks?

5. Are there any demographic characteristics of the participants which affect their ability to efficiently perform elementary data collection tasks?

6. Are there any elementary data collection tasks in which three-dimensional graphs facilitate more accurate solutions than two-dimensional graphs and tables?

7. Are there any elementary data collection tasks in which three-dimensional graphs facilitate more efficient responses than two-dimensional graphs and tables?

8. Which graphical format is appropriate for a given task?

The first two investigative questions will be addressed in the literature review. Investigative questions three through eight will be answered through an experiment.

Scope/ Limitations of the Research

Researchers have studied a variety of topics related to graphical presentation. Many of the experimental results from research studies performed to determine the effectiveness of graphics have been contradictory (9:464). The contradictory results are due to the vast assortment of dependent variables used in graphics research. The following are the major dependent variables used in graphics research: (1) interpretation accuracy, (2) problem comprehension, (3) task performance, (4) decision quality, (5) speed of comprehension, (6) decision speed, (7) memory - recognition and recall, and (8) viewer preference (9:468). This thesis will focus on three of these dependent variables: interpretation accuracy, task performance and decision speed. There will be three independent variables considered in the study: task anchoring (question type), mode of presentation, and data-set combination.

The presenter has a multitude of graphical methods available to consider when preparing information for presentation. The following are some examples of graphical methods: line charts, bar charts, pie charts, dot charts, Tukey box plots, and symbol charts. The various graphs can be displayed either two-dimensionally or three-dimensionally. However, this study will only compare and contrast tables, two-dimensional line and bar charts, and three-dimensional line and bar charts. Chapter III, Methodology, describes the use of these graphical methods in the construction and design of the experiment to determine if and how three-dimensional graphs are more accurate and

efficient than two-dimensional graphs and tables when presenting alternatives to decision makers.

Conclusion

The literature Review, Chapter II, discusses the use of business graphics in business, and explains why graphics have become such an important element in the presentation of information either to internally or to the public (first and second investigative questions). The Methodology, Chapter III, explains and justifies the experimental design, pertinent concepts, construction of the experimental item, and the procedures used for administering the experiment. Chapter III also provides a brief discussion of the statistical analysis to be used on the experimental results. The Data Description and Analysis, Chapter IV, discusses the data retrieval processes, and the statistical analysis techniques used to justify the significant differences in the data. Finally, Chapter V, Findings and Conclusions, discusses the conclusions of the tested hypotheses and provides recommendations for future research.

II. Literature Review

Introduction

Advanced computer graphics packages have become powerful and essential tools in communicating information to decision-makers. Whether an individual's presentation is a success (selling the audience on a point of view) or failure hinges on three factors: how convincing the presentation is, how efficient graph interpretation is, and how accurately decision makers can interpret the graphs. Thus, the presenter is faced with an unenviable task. The presenter must choose a graphical format that will capture the audience's attention and enable them to make an accurate decision in a limited time frame. Before presenters can make these kinds of decisions, the effect of each graphical format on an individual's decision should be considered. The objective of this thesis is to determine whether or not three-dimensional graphs are more accurate and efficient than two-dimensional graphs and tables when presenting alternate choices to decision makers. This literature review will focus on the background of graphical research and the major findings.

This chapter is divided into four separate sections. The first section, use of graphics, discusses how computer graphics, especially in business, have become an important element in the presentation of information either internally or to the public. The second section addresses the criteria for high integrity graphics and the human perceptual and memory mechanism limitations. The third section is a comprehensive review of past research on graphical topics, and the fourth section is a conclusion which addresses how the review relates to our thesis objective.

Use of Graphics

In 1984, marketing specialists estimated the computer graphics industry was growing at an annual rate of approximately 60 to 70 percent (9:463). Now, in 1994, because of

computer hardware and software technology advances, businesses have capabilities they have never had before. Government, corporations, and even small businesses use advanced computer graphics packages to generate presentations to communicate information. Often, presenters display cost data in graphical form to concisely present information to executives. The DoD uses these graphics packages to perform risk, cost, and failure analysis as well as to portray large quantities of information necessary to both operational and acquisition decision makers.

Accountants as well as cost analysts are extremely concerned with presenting data with accuracy and clarity to increase the executive's ability to make a decision. Graphics are typically used to make a point, illustrate a trend, or make comparisons so the data are more easily understood. Accountants often have to persuade an executive to allocate funds, and graphics are the most effective tool. A senior accounting manager of a major oil firm stated that an accountant not only has to be good at his or her job, but he or she must be a good salesperson to succeed (20:18). How a person presents ideas is critical in the decision making process, and using graphics to communicate those ideas is a method for success (20:18). Accountants use graphics for the following reasons: problem comprehension (graphs have dimensionality), task performance and decision quality (improvement in comprehension of data), speed of comprehension, decision speed, memory of information, and viewer preference (14:19-20).

Newspapers are also interested in graphics capabilities. Newspapers now realize that to lure readers, graphics are required to attract their attention. According to Roger Fidler, Knight-Riddler's director of graphics and newsroom technology, "the great demand for informational graphics has come largely from a recognition that newspaper's readership is declining and that newspapers must become more effective at visual communications" (26:318). "The American Society of Newspaper Editors found that 92% of newspapers

planned to use more informational graphics in the next five years, and 90% of newspapers said graphics would play an even bigger role by the year 2000" (26:318).

Graphics Criteria and Perceptual Limitations

Graphical research started in the early part of this century. In 1915, a group of statisticians formed the Joint Committee on Standards for Graphic Presentations. The objective of this committee was to establish "convenient standards" for presenting statistical data in graphical form (2:791). The committee hypothesized that these standards would make graphs more widely used, "with a consequent gain to mankind because of the greater speed and accuracy with which complex information may be imparted and interpreted" (2:791). The standards they developed focused on the format of line graphs. Since this original study, many researchers and organizations have focused their efforts toward the development of graphical standards. While some of the documented standards focused on improving the presentation or professional appearance of graphs (1, 16, 17), others focused more importantly on enhancing the analytical usefulness of the graphs (3, 13, 20, 22). In the article "Criteria for High Integrity Graphics," Christensen and Larkin identified nine "criteria for high integrity graphics," and reported that "graphs which violate the criteria can mislead decision makers" (5:130). The following are the nine criteria that when violated may mislead a decision maker (5:131-145):

(1) The graph should agree with the data - Tufte's "lie factor" defined as the "size of the effect shown in the graph divided by size of the effect in the data" (25:57).

(2) Follow normal temporal sign conventions.

(3) The stratum with the least variability should be on the bottom in strata (area) chart.

(4) Labels should be correct.

(5) The number of dimensions in the graph should not exceed the number of dimensions in the data.

(6) Avoid unusual scaling.

(7) The scale range should be close to the data range.

(8) Avoid arbitrary changes to grid proportions.

(9) Beware of omitted data.

The implication of Christensen and Larkin's study is simple: if the criteria are not followed, the graphs will be misperceived and inappropriate decisions will be made. The criteria identified by Christensen and Larkin will be followed in this experiment, except the fifth criteria, to control any confounding effect that graphical formatting has on accuracy and efficiency. In this experiment, three-dimensional graphs will be compared to tables and two-dimensional graphs. The data portrayed in this experiment is two-dimensional; however, three-dimensional graphs will be studied using this two-dimensional data. Although three-dimensional graphs will be compared, the third dimension is for aesthetic purposes only, and has no value associated with it.

Although complying to graphical standards is an important aspect in aiding graphical perception, it is not the only aspect we should be concerned with. Individuals who prepare graphics for presentation often do not take into consideration the human perceptual and memory mechanisms needed to retain and understand the presented data (6:24). These graphics preparers need to understand how people process data so they can prepare and structure effective reports. Behavioral scientists have noted that the human perceptual system is limited in its ability to process information (6:27). People have a finite capacity to process information concerning absolute judgments. "A person's ability to hold only seven items in immediate memory for comparison purposes has been labeled span of absolute judgment" (6:28). This small span of absolute judgment creates a need to

group data. Therefore, it is important that report formats use groupings that assist the memory input process and do not overload the decision maker (6:28). When someone looks at a graph, the information is visually decoded by his or her visual system.

> A graphical method is successful only if the decoding is successful. Graphical perception is the instantaneous perception of the visual held without apparent mental effort, but much of the power of graphs, and what distinguishes them from other information tools, comes from the ability of our preattentive visual system to detect geometric patterns and assess magnitudes. (6:828)

Theoretical and experimental investigations of graphical perception identified ten graphical perception tasks used to visually extract quantitative information from graphs. Through experimental research, Cleveland sequentially ordered the tasks as follows (listed from the most accurate to the least accurate): position along a common scale, position on identical but nonaligned scales, length, angle, slope, area, volume, density, color saturation and color hue. Cleveland has determined that the order these tasks are selected will increase the accuracy of a person's perceptions of important patterns in the data (6:830).

The implication of Cleveland's findings is significant because it allows us to determine which mode of presentation is best. For example, graphs that show changes along a common scale such as bar or line graphs, should be used as often as possible because people can more accurately interpret them. On the other hand, graphs that exhibit changes in area or volume such as pie charts, are an extremely inferior tool for presenting information because people cannot accurately interpret them. Finally, his results indicate that color should not be used to identify changes in magnitude. Color should only be used to identify graphical elements or to attract attention. The experiment performed for this thesis will use only bar and line graphs to minimize the possible confounding effects these graphical elements have on accuracy and efficiency. Color will be used in the experiment to only distinguish between the graphical elements.

Comprehensive Review of Applicable Research

Although the criteria for graphical excellence and the identification of the elementary graphical-perception tasks improved how accurately graphs could be interpreted, the question of whether or not graphs were better than tables for data presentation still remains. Much of the early research that compared graphs to tables provided conflicting results. DeSanctis (9), Davis (8), Tan and Benbasat (22), and Jarvenpaa and Dickson (13), provide numerous examples of studies that conflict (please refer to Table 1). Some of the studies indicated graphs were superior, while others indicated they were not superior. There are still other studies where the findings are equivocal.

Table 1 lists the studies which pertain to either tables, bar or line graphs. These studies were chosen because of their relevancy to this study. The left column in the table lists name(s) of the researchers responsible for the associated studies. The second and third columns in the table display the associated independent and dependent variables for each of the studies. If there is more than one dependent variable listed, then the variables will be numbered. The last column in the table lists the associated results of the study. If the results are associated with a specific dependent variable, then the result will display the same number as the dependent variable in the previous column.

Table 1. Summary of Research Comparing Graphs and Tables.

Authors	Independent Variable	Dependent Variable	Results
Washburne, 1927 (9)	Tables vs. Bar graphs vs. Line graphs	Comprehension of: 1. Complex static comparisons 2. Dynamic comparison 3. Specific amts.	Best Display: 1. Bar graph 2. Line graph 3. Table
Carter, 1947 (9)	Tables vs. Graphs	Problem Solving: 1. Speed 2. Accuracy	Best Display: 1. Graphs 2. Tables

Table 1. Summary of Research Comparing Graphs and Tables (continued).

Authors	Independent Variable	Dependent Variable	Results
Carter, 1948 (9)	Tables vs. Graphs; observed pts vs. interpolation	Interpretation speed and accuracy	Tables best for pt reading; graphs for interpolation
Feliciano et al., 1963 (9)	Tables vs. Bar graphs	Interpretation	Graphs are better
Wainer & Reiser, 1976 (9)	Tables vs. Bar graphs	Reaction time	Bar charts are better
Benbasat & Schroeder, 1977 (9)	Tables vs. Graphs	Performance; report preference; decision effectiveness	Graphs are better
Zmud, 1978 (9)	Tables vs. Bar graphs vs. Line graphs	1. Preference/ perceived relevance 2. Perceived accuracy	<u>Best Display</u>: Line charts (best); tables; bar charts (least preferred)
Lusk & Kersnick, 1979 (9)	Tables vs. Graphs	1. Performance 2. Learning	<u>Best Display</u>: Tables for both
Lucas & Nielson, 1980 (9)	Tables vs. Graphs	1. Performance 2. Learning	1. No effect 2. No effect
Davis, 1981 (9)	Tables vs. Graphs	1. Performance 2. Confidence 3. Decision Time	1. No effect 2. No effect 3. No effect
Ghani, 1981 (9)	Tables vs. Graphs	1. Performance 2. Decision Time 3. User preference	<u>Best Display</u>: 1. Tables 2. Tables 3. Feeling type - graphs; thinking type - tables
Lucas, 1981 (9)	Tables vs. Graphs	1. Problem understanding 2. Task enjoyment 3. Perceived usefulness of report	<u>Best Display</u>: 1. Graphs 2. Graphs 3. Tables

Table 1. Summary of Research Comparing Graphs and Tables (continued).

Authors	Independent Variable	Dependent Variable	Results
Powers et al., 1982 (9)	Tables vs. Graphs	Comprehension scores	Tables are better
Watson & Driver, 1983 (9)	Tables vs. 3D graphs	1. Immediate recall 2. Delayed recall	Best Display: 1. No effect 2. No effect
Zmud, 1983 (9)	Tables vs. Graphs; Task complexity	Decision quality	Graphs are better for low complexity tasks; tables for high complexity
Blocher et al., 1986 (8)	Tables vs. Graphs; Task complexity	Decision quality	Graphs are better for low complexity tasks; tables for high complexity
Dickson et al., 1986 (8)	Tables vs. Graphs Bar graphs/ Line graphs	1. Interpretation accuracy 2. decision quality	Best Display: 1. No effect/ No effect 2. No effect/ Line graphs are better
Jarvenpaa & Dickson, 1986 (13)	Tables vs. Graphs	1. Retrieval of info. 2. Recall info. 3. Message comprehension 4. Spotting trends 5. Recall large amounts of data	Best Display: 1. No effect 2. No effect 3. No effect 4. Graphs 5. Graphs
Davis, 1989 (8)	Tables vs. Graphs	Performance	Graphs only better when visual cues aid in answering question.

In an attempt to understand these conflicting results, DeSanctis wrote the paper, "Computer Graphics as Decision Aids: Directions for Research" (9). This paper is instrumental for much of today's research because it identifies the major dependent variables in graphics research and provides a rationale for their use. The following are the major dependent variables used in graphics research (9:468):

(1) Interpretation Accuracy - Data displayed in a graph should be understood by the reader.

(2) Problem Comprehension - A graph has dimensionality which provides a "different" and "better" perspective on the data. Understanding of the information in a display improves, and the user is more likely to identify problems when they exist.

(3) Task Performance - Because comprehension of data is better, performance on a task involving use of that data will tend to improve.

(4) Decision Quality - Because the user can better understand the problem, the individual is more likely to make a good decision.

(5) Speed of Comprehension - Graphs have a summarizing effect. They reduce information overload.

(6) Decision Speed - Because the information can be comprehended faster, the time required to make a decision will be reduced.

(7) Memory for Information - Graphs can be remembered because the spatial aspect of a graph provides additional information to a reader beyond the data itself. Information serves as a "cue" during recall.

(8) Viewer Preference - The spatial aspect of a graph makes it visually appealing. Special features, such as color, shading, realism and complexity can be added to a graph to make it even more appealing to the reader.

Collectively, these variables are the basis for measuring the effectiveness of a data presentation format in experimental research.

The experiment for this thesis considers the following variables: interpretation accuracy, decision speed and task performance. Tan and Benbasat suggest that the reason

for the conflicting results across these studies is the lack of a cumulative approach in research efforts. They believe that much of the research has been diverse and that researchers do not consider similar variables in their experiments which will help establish consistency. Tan and Benbasat identify two of the most common problems with the research:

> First, there are problems that affect the internal validity of findings such as poorly designed presentations, poor resolution of the medium used, or the confounding of multiple effects (e.g., colors with graphics). Second, some of the literature tends to treat graphics as a global variable and fails to realize that differences among various graphical forms, such as lines, bars, or pie charts, might account for the contradictory results. (22:168)

However, the most important problem with the research was originally cited by Jarvenpaa, Dickson, and DeSanctis in 1985. Tan and Benbasat summarize Jarvenpaa, Dickson, and DeSanctis' findings with the following statement: "The major cause of contradictory results is the various and differing tasks used in these experiments and the match (or mismatch) between the task [i.e. the action to be performed with respect to the graph] and presentation method [i.e. the graph format]" (22:168). In light of these findings Jarvenpaa, Dickson, and DeSanctis state that "future research efforts will keep producing contradictory results unless researchers develop some type of taxonomy of task and start interpreting the results within the taxonomy (13:144)." The term "taxonomy" is defined by Webster as, "the study of the general principles of scientific classification" (27:1195). In this sense, Jarvenpaa, Dickson, and DeSanctis are challenging researchers to develop a method for characterizing tasks.

Several studies accomplished since 1985 support the proposition that the appropriate graphical format is dependent on task characteristics (refer to Table 1). For example, a study performed by Dickson, DeSanctis, and McBride found that tables were more appropriate for tasks that required an accurate interpretation of values. On the other

hand, they showed graphs were better for interpreting trends in large amounts of time dependent data or for recalling fairly specific facts about large quantities of data (10:46). Research performed by Jarvenpaa and Dickson also supports these same findings (12:2). Another study that supports the proposition was accomplished by Davis. The study developed a taxonomy for determining relative levels of task complexities and examined whether the information desired by the decision maker was a task characteristic that affected the appropriateness of the graphical format. Davis concluded "that tabular presentations are an effective and efficient form of presentation for a wide range of questions while graphical forms of presentation are appropriate for a limited set of questions" (8:503). Thus, the task characteristic is an important variable that needs to be controlled when determining the appropriateness of the graphical format.

One of the most important task characteristics to control is task complexity, the difficulty of extracting an answer from a presentation. Task complexity is dependent upon what the user of the presentation must do to isolate and extract the relevant information (8:499). To control task complexity, it is important to be able to measure it. This is important, because if the experiment is designed assuming low task complexity, and the experiment is much more difficult for the subjects than expected, then the task complexity could then have an affect on the dependent variables. The method presented by Davis asserts that task complexity is dependent on the number of steps taken to extract the data that must be accomplished to "isolate the relevant information" (8:499). In a study Davis performed with Lauer, Groomer, Jenkins, and Yoo, they found that these steps are associated with several different types of activities. The activities for evaluating task complexity are (in increasing order of complexity) (8:499):

(1) <u>Identifications</u> - Identifying a line on a line graph or row in a table.

(2) <u>Scans</u> - Locating the highest points on a line in a line graph.

(3) Comparisons - Comparing two amounts or slopes.

(4) Estimations - Estimating the approximate sum or difference of two numbers. Thus, by counting the number of steps that are required to perform each task, the relative complexity of the task can be determined. For example, to extract information from a line graph (scans), the subject would first look to the y-axis and compare among the data to see which entity had the highest point. Then the subject would then have to follow this point to the x-axis to obtain the correct value on the x-axis which will answer the question. To scan this data, two steps were taken to obtain the answer. In this study, task complexity will be measured using the method advocated by Davis as stated above.

Another task characteristic developed by Tan and Benbasat (22) utilizes a concept called "anchoring" to formulate a taxonomy for characterizing tasks and graphs. These taxonomies are based on operational definitions of x-value anchoring, y-value anchoring, and entity anchoring. Anchoring is defined as "the phenomenon that specific and diverse parts of an image are segmented by graph readers to act as salient and relevant cues, or anchors, when extracting different classes of information (e.g., x-value, y-value, and entity information) from a presentation" (22:171). In other words, anchoring is the technique readers use to break down and interpret graphs.

Anchoring is categorized in three levels: high, medium, and low. A graph has high anchoring if it provides a strong visual cue to the information in question. For example, a vertical bar chart has high x-value anchoring because bars are tied to a discrete value on the x-axis. Thus, the x-value can easily be read from the chart without having to make any judgments.

A graph has low anchoring if it does not provide a visual cue to the reader. A line graph is a good example. If you are interested in determining a specific value of x for a particular point on the graph, then you must perform a series of steps. Because a line is continuous, the reference point in the line must be isolated from the other points, then that

point must be projected vertically down to the x-axis. Finally, the value of the x-axis at the projected point must be interpolated. Because these steps complicate the extraction of data, they are associated with low anchoring. Y-value anchoring is essentially the same as x-value anchoring except that it refers to the values associated with the y-axis.

Entity anchoring is somewhat different, because it refers to how well each series (an element of a graph legend) can be distinguished from each other. For example, if the performance of four regions (North, South, East, and West) were to be compared over a specific period of time then each of these regions is an entity.

Tan and Benbasat suggest that bar and line graphs have the following characteristics:

	x-Value Anchoring	y-Value Anchoring	Entity Anchoring
Vertical Bar Graphs	High	Moderate	Low
Line Graphs	Low	Low	High

For this experiment, it is necessary to also apply the concept of anchoring to tables. Based on the previous discussion of anchoring and the format of a table, it is reasonable to assume that tables have the following anchoring characteristics:

	x-Value Anchoring	y-Value Anchoring	Entity Anchoring
Tables	High	High	High

Tables have high anchoring in all three categories because they display the y-value in a row and column matrix which gives strong visual cues to the x-value (the row heading) and entity (the column heading).

Finally, these anchoring characteristics are also assumed to hold true for the three-dimensional graphics used in this experiment. This is a reasonable assumption because the three-dimensional graphs in the experiment will add depth in the third dimension for only aesthetic purposes, and do not provide any additional information. Before these anchoring characteristics of graphs and tables can be used to predict which mode of presentation is appropriate for a given task, tasks must also be defined within the anchoring framework (22:169-173).

The x-axis, y-axis, and the symbols used to identify entities are considered graphical components. Tan and Bendbasat suggest that a task has high anchoring for a component if the component is represented in the question as either a given value or an unknown. For example, the following question has high x-value (x-axis) and high y-value (y-axis) anchoring: "Company A's revenues in period two are _____ ?" A question has low anchoring if the component is not represented in the question as a given or unknown. An example of a question that has low x-value anchoring and low y-value anchoring is: "Which company has the largest change in revenues between any two periods?" Finally, questions can be composed of a mixture of high x, low y; or low x, high y-value anchoring. An example of a question that has a high x-value anchoring and low y-value anchoring is: "Are company A's revenues from period five to seven generally increasing or decreasing?" (22:171).

Conclusion

Advanced computer packages have become powerful and essential tools in communicating information to decision-makers. Graphics have become an important element in the presentation of information either internally or to the public (first investigative question). A significant amount of research has focused on the effect graphical format has on an individual's decision. Researchers have identified criteria that

help standardize graphs and reduce the risk of misinterpretation by the user (second investigative question). Also, elementary graphical-perception tasks have been identified to improve the accuracy with which graphical information can be interpreted. Finally, there has been a significant amount of research that has attempted to identify which mode of presentation is most appropriate for a given task. The implication of this research is simple: when constructed properly for a particular task, graphs are an accurate and effective tool for conveying information to decision makers. Although this implication is substantial, it only addresses the usefulness of graphs for decision support. Furthermore, research has neglected to examine the effect that three-dimensional graphs have on decision-making. Thus, this study will examine how efficient and accurate three-dimensional graphs are with respect to two-dimensional graphs and tables.

The next Chapter (III), the Methodology, explains and justifies the experimental design, pertinent concepts, construction of the experimental item, procedures for administering the experiment, and the characteristics of sound measurement. It also provides an in depth discussion of the statistical techniques used to justify the significant differences in the accuracy and time response data.

III. Methodology

This chapter describes the methodology used to research the investigative questions and hypotheses concerning whether or not, and by how much, three-dimensional graphs are more efficient and accurate than two-dimensional graphs and tables when presenting alternatives to decision-makers. There are eleven sections in this chapter. Section one gives a brief introduction to the objectives of this research project and its associated hypotheses and investigative questions. Section two discusses the within-subject factorial design with repeated measures used in the experiment. Section three describes how the experimental package was developed. Section four explains the statistical procedures used to analyze the results of the experiment. Section five discusses the characteristics of sound measurement. Section six describes the construction of the experimental item. Section seven provides a reference to the experimental item used and the associated macros and code developed for the design of the experiment. Section eight discusses the procedures for administering the experimental package. Section nine explains the experimental procedures for administering the experiment to subjects. Section ten describes the development of the End-of-Exercise Questionnaire. Finally, section eleven summarizes the chapter.

Research Questions

The primary objective of this study is to determine whether or not, and by how much, three-dimensional graphs are more efficient and accurate than two-dimensional graphs and tables when presenting alternatives to decision-makers. The investigative questions which relate to the experiment are as follows:

3. Do various modes of graphical presentation affect the accuracy associated with given elementary data extraction tasks?

4. How efficient are the various modes of graphical presentation associated with given elementary data extraction tasks?

5. Are there any demographic characteristics of the participants which affect their ability to efficiently perform elementary data collection tasks?

6. Are there any elementary data collection tasks in which three-dimensional graphs facilitate more accurate solutions than two-dimensional graphs and tables?

7. Are there any elementary data collection tasks in which three-dimensional graphs facilitate more efficient responses than two-dimensional graphs and tables?

8. Which graphical format is appropriate for a given task?

The primary null hypotheses (H_O) for the research are:

1. Manipulation of the mode of presentation and task anchoring does not affect the accuracy of data interpretation.

2. Manipulation of the mode of presentation and task anchoring does not affect the response time of data interpretation.

3. The level of graphics training does not affect the efficiency of decision making.

4. The rank of the subjects does not affect the efficiency of decision making.

5. Gender does not affect the efficiency of decision making.

6. The level of education does not affect the efficiency of decision making.

Investigative questions one and two were addressed in the literature review and are answered in Chapter II. A graphical experiment was designed using a microcomputer to answer investigative questions three through eight. This experiment presented a business scenario to test Air Force Institute of Technology (AFIT) Professional Continuing Education (PCE) students. The experiment attempted to determine how well DoD decision makers perform elementary data collection tasks using various graphs or tables. The experiment also assessed the time DoD decision makers spent completing the various modes of presentation. Once questions three, four, and five are answered (Chapter 4),

determining whether or not three-dimensional graphs are better than two-dimensional graphs for particular tasks (questions six, seven and eight) will be examined (Chapter 5).

Experimental Design

The experiment used a randomized order within-subject factorial design with repeated measures. The repeated measures portion of the experimental design was chosen for two main reasons: (1) it eliminated the experimental bias caused by variability among the subjects, and (2) it reduced the number of subjects required (29:517). The factorial design was also chosen because of the need to analyze the main and interactive effects of the three experimental variables, mode of presentation, anchoring and data-set. "Information obtained from factorial experiments is more complete than that obtained from a series of single factor experiments, in the sense that factorial experiments permit the evaluation of interaction effects. An interaction effect is an effect attributed to the combination of variables above and beyond that which can be predicted from variables considered singly" (28:309).

Factorial experiments permit the researcher to make decisions that have a broad range of applicability. In addition to information about how the experimental variables operate in relative isolation, the researcher can predict what will happen when two or more variables are combined with one another (28:309).

The design of a factorial experiment in concerned with the following questions (28:310):

1. What factors should be included?
2. How many levels of each factor should be included?
3. How should the levels of the factors be spaced?
4. How should the experimental units be selected?
5. How many experimental units should be selected for each treatment combination?

6. What steps should used to control experimental error?

7. What criterion measures should be used to evaluate the effects of treatment factors?

8. Can the effects of primary interest all be estimated adequately from the experimental data that will be obtained.

The Experiment

An experiment was conducted on AFIT PCE students to test how well DoD decision makers accurately perform elementary data collection tasks, and to measure the efficiency of various modes of presentation (dependent variables). PCE students were chosen to participate in the experiment because they are representative of DoD decision makers. In addition, they were an extremely accessible source.

The factorial experiment was designed to analyze the manipulation of three factors or independent variables, anchoring, mode of presentation, and data-set to determine their effects on the response variables of degree of accuracy, and response time (efficiency). A factor is a series of related treatments or related classifications. The number of levels within the factor are determined by the degree to which the experimenter desires to investigate each factor (28:311). In this experiment five treatment levels were selected for mode of presentation: table, two-dimensional bar, two-dimensional line, three-dimensional bar, and three-dimensional line. Four treatment levels were selected for task anchoring: high x, high y; high x, low y; low x, high y; and low x, low y value anchoring. The third factor, data-set combination, used in the study is a result of pilot testing. Despite efforts to disguise the data-set, after observing twenty graphs, most of the subjects in the pilot test realized they were repeatedly being asked the same four questions about the same data-set. To eliminate this source of experimental bias, an additional data-set was added to create two unique experimental combinations.

Tables 2 and 3 illustrate the two data-set combinations. Both tables display four levels of Anchoring (c_1 - c_4). These four levels of anchoring are associated with high x-

high y, high x-low y, low x-high y, and low x-low y tasks, respectively. Both tables also show five modes of presentation (b_1-b_5). These modes of presentation are associated with tables, two-dimensional bar, three-dimensional bar, two-dimensional line, and three dimensional line, respectively. Two data-sets (ds-1 and ds-2) comprised each combination. For example, ds-1 was used for all the tables, two-dimensional bar, and three-dimensional line charts/graphs, and ds-2 for all the three-dimensional bar and two-dimensional line graphs for data-set combination one (Table 2). Data-set combination two (Table 3) utilized the opposite data-sets than the previous data-set combination.

Table 2. Data-Set Combination One.

			Mode of Presentation (B)				
			b_1	b_2	b_3	b_4	b_5
Task	(HH)	c_1	ds-1	ds-1	ds-2	ds-2	ds-1
Anchoring (C)	(HL)	c_2	ds-1	ds-1	ds-2	ds-2	ds-1
	(LH)	c_3	ds-1	ds-1	ds-2	ds-2	ds-1
	(LL)	c_4	ds-1	ds-1	ds-2	ds-2	ds-1

Table 3. Data-Set Combination Two.

			Mode of Presentation (B)				
			b_1	b_2	b_3	b_4	b_5
Task	(HH)	c_1	ds-2	ds-2	ds-1	ds-1	[illegible]-2
Anchoring (C)	(HL)	c_2	ds-2	ds-2	ds-1	ds-1	ds-2
	(LH)	c_3	ds-2	ds-2	ds-1	ds-1	ds-2
	(LL)	c_4	ds-2	ds-2	ds-1	ds-1	ds-2

The three factors, anchoring, mode of presentation, and data-set combination as well as their associated treatment levels, are all qualitative variables and were analyzed as such in the experiment.

Dimensions of a factorial experiment are indicated by the number of factors and the number of levels of each factor. The dimensions of this experiment containing three factors, data-set combination (2 treatment levels), mode of presentation (5 treatment levels), and task anchoring (4 treatments levels), and is described as a 2 x 5 x 4 (2 by 5 by 4) factorial design. The treatment combinations for the 2 x 5 x 4 design are represented in Tables 4 and 5:

Table 4. Data-Set Combination One (A).

			Mode of Presentation (B)				
			b1	b2	b3	b4	b5
Task	(HH)	c1	abc111	abc121	abc131	abc141	abc151
Anchoring (C)	(HL)	c2	abc112	abc122	abc132	abc142	abc152
	(LH)	c3	abc113	abc123	abc133	abc143	abc153
	(LL)	c4	abc114	abc124	abc134	abc144	abc154

Table 5. Data-Set Combination Two (A).

			Mode of Presentation (B)				
			b1	b2	b3	b4	b5
Task	(HH)	c1	abc211	abc221	abc231	abc241	abc251
Anchoring (C)	(HL)	c2	abc212	abc222	abc232	abc242	abc252
	(LH)	c3	abc213	abc223	abc233	abc243	abc253
	(LL)	c4	abc214	abc224	abc234	abc244	abc254

In this schematic, b_1 - b_5 represent the treatment levels of mode of presentation, c_1 - c_4 represent the treatments levels for the task anchoring, a_1- a_2 represent the treatment levels for the data-set combination. In this 2 x 5 x 4 experiment, forty possible treatment combinations (a x b x c) were formed.

Finally, level of complexity was the one control variables for the experiment. Since, task complexity can be a confounding variable it is important that it be controlled. This experiment applied low task complexity. The researchers kept the experiment simple. The subjects were tasked to extract data directly from the charts/ graphs. They were not asked to manipulate data or perform mathematical calculations of any kind. By keeping complexity low the results will be more generalizable.

Statistical Analysis

The general format used to identify differences between the various experimental treatment means was the Multifactor Analysis of Variance with Repeated Measures technique. This method was used to determine the main and interaction effects of the mode, task, and data factors on the response time when the subject is observed under more than one treatment condition. This procedure controls the differences between subjects that are often quite large in behavioral studies and allows a comparison between treatment means to be made.

This study used a 2 x 5 x 4 factorial experiment in which there are repeated measure on the last two factors. Table 6 illustrates this case:

Table 6. Repeated Measures Illustration.

	b1	b2	b3	b4	b5
	c1 - - - c4	c1 - - - c4	c1 - - - c4	c1 - - - c4	c1 - - - c4
a1	G1 - - - G1	G1 - - - G1	G1 - - - G1	G1 - - -G1	G1 - - -G1
a2	G2 - - - G2	G2 - - - G2	G2 - - - G2	G2 - - - G2	G2 - - - G2

There are 31 subjects in each group (G). Each subject is observed under all bc combinations of factors B (mode) and C (task), but only under a single level of factor A (data set combination). Thus, there are 2 groups of 31 subjects each (62 subjects in all) and there are bc (20) observations of each subject.

The linear model that the analysis is based on is as follows:

$$X_{abcm} = \mu + \alpha_a + \pi_{m(a)} + \beta_a + \alpha\beta_{ab} + \beta\pi_{am(a)} + \gamma_c + \alpha\gamma_{ac} + \gamma\pi_{cm(a)} + \beta\gamma_{bc} + \alpha\beta\gamma_{abc} + \beta\gamma\pi_{bcm(a)} + \varepsilon_{o(abcm)}. \quad (1)$$

In this notation, X is the observed response and is a function of:

(1) μ which is a constant,

(2) α which represents the main effect of the factor data-set combination (i = 1, 2, where 1 = the first data-set combination, 2 = the second data-set combination),

(3) β which represents the main effect of the factor mode of presentation (j= 1, . . . , 5, where 1 = table, 2 = two-dimensional bar chart, 3 = three-dimensional bar chart, 4 = two-dimensional line chart, 5 = three-dimensional line chart),

(4) γ which represents the main effect of the factor task anchoring (k = 1, . . . , 4, where 1= High X - High Y anchoring, 2 = High X - Low Y anchoring, 3 = Low X - High Y anchoring, 4 = Low X - Low Y anchoring),

(5) $\pi_{m(i)}$ which is the effect of subject m that is nested under level α_i,

(6) the two-way and three-way interactions $\alpha\beta$, $\beta\pi$, $\alpha\gamma$, $\gamma\pi$, $\alpha\beta\gamma$, and $\beta\gamma\pi$, receptively (28).

Finally, ε represents the experimental error term. The dummy variable "o" indicates that the experimental error is nested within the individual observation. The hypothesis for the linear model in Equation (1) is as follows:

H_o: $\alpha = \beta = \gamma = \pi = \alpha\beta = \beta\pi = \alpha\gamma = \gamma\pi = \alpha\beta\gamma = \beta\gamma\pi = 0$

H_a: At least one of the effects is not equal to zero.

The analysis of variance for this experiment takes the form shown in Table 7 (28:540):

Table 7. Summary of Analysis of Variance.

Source of Variation	df	E(Ms)
Between Subjects	na-1	
A	a-1	$\sigma_\varepsilon^2 + bc\sigma_\pi^2 + nbc\sigma_\alpha^2$
Subject within groups [error (a)]	a(n-1)	$\sigma_\varepsilon^2 + bc\sigma_\pi^2$
Within subjects	na(bc-1)	
B	b-1	$\sigma_\varepsilon^2 + c\sigma_{b\pi}^2 + nac\sigma_b^2$
AB	(a-1)(b-1)	$\sigma_\varepsilon^2 + c\sigma_{b\pi}^2 + nc\sigma_{ab}^2$
B x subject within groups [error (b)]	a(n-1)(b-1)	$\sigma_\varepsilon^2 + c\sigma_{b\pi}^2$
C	c-1	$\sigma_\varepsilon^2 + b\sigma_{\gamma\pi}^2 + nab\sigma_\gamma^2$
AC	(a-1)(c-1)	$\sigma_\varepsilon^2 + b\sigma_{\gamma\pi}^2 + nb\sigma_{\alpha\gamma}^2$
C x subject within groups [error (c)]	a(n-1)(c-1)	$\sigma_\varepsilon^2 + b\sigma_{\gamma\pi}^2$
BC	(b-1)(c-1)	$\sigma_\varepsilon^2 + \sigma_{\beta\gamma\pi}^2 + na\sigma_{\beta\gamma}^2$
ABC	(a-1)(b-1)(c-1)	$\sigma_\varepsilon^2 + \sigma_{\beta\gamma\pi}^2 + n\sigma_{\alpha\beta\gamma}^2$
BC x subject within groups [error (bc)]	a(n-1)(b-1)(c-1)	$\sigma_\varepsilon^2 + \sigma_{\beta\gamma\pi}^2$

The manner in which the total variation is partitioned in Table 7 is quite similar to that used in an a x b x c factorial experiment with no repeated measures. However, in an experiment having repeated measures, the within-cell variation is divided into two non-overlapping parts (refer to Figure 3). "One part is a function of experimental error plus the main effects of subjects within groups, i.e., individual differences. The other part is a function of experimental error and B x subject-within-group interaction" (29:520).

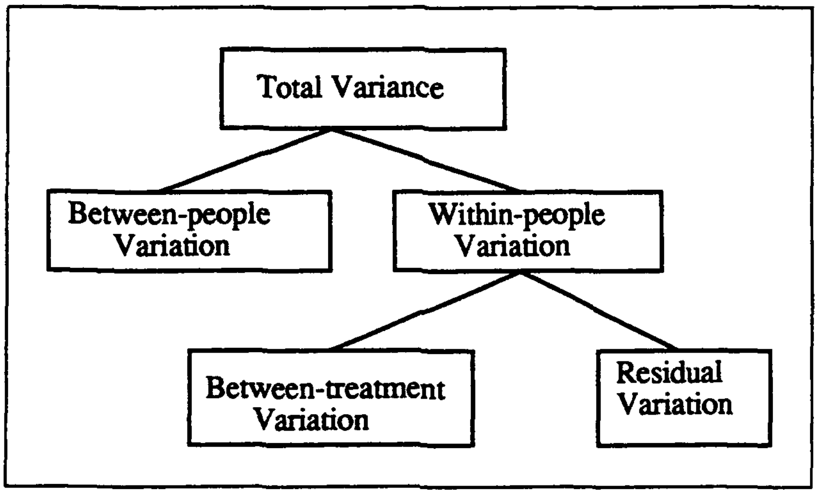


Figure 3. Schematic Representation of the Analysis of Variance (28:266).

The ANOVA was used to analyze differences in treatment means associated with the experimental variables mode, task, and data set combination. The F test is used to test whether or not there are any statistical differences in the factor level means. The expected values of mean squares shown in the Table 7 indicate the appropriate F ratios to be used in making statistical decisions. For example, to test the hypothesis that $\sigma^2_\alpha = 0$,

$$F = \frac{MS_a}{MS_{\text{subj within groups}}}. \tag{2}$$

The denominator of Equation (2) is commonly referred to as the mean square error between groups. To test the hypothesis that $\sigma^2_{\alpha\beta\gamma} = 0$, the appropriate F ratio is

$$F = \frac{MS_{abc}}{MS_{BC \times \text{subj within groups}}}. \tag{3}$$

The denominator in Equation (3) is commonly referred to as the means square error within "since it forms the denominator of F ratios used in testing the effects which can be classified as part of the within subject variation" (29:521). Large values of F support the

alternative hypothesis, because the numerator will be larger than the denominator if the hypothesis is false. Values of F close to 1 support the null hypothesis, since the numerator and denominator have the same expected value if the hypothesis is true (20:547).

The validity of this experiment is based on several assumptions. The first assumption is that the observations represent random samples from the population. This assumption was met by randomly assigning the subjects to the two test groups and randomizing the order in which each subject received the treatments. The second assumption is that the observations are drawn from a normally distributed population. To satisfy this assumption the response times were transformed using the natural logarithm. The Wilk-Shapiro/ Rankit Plot was used to validate normality. The other assumptions are "about the form of the variance-covariance matrix associated with the joint multivariate normal distribution of the random variables in the model" (29:517). Specifically, the variance-covariance matrices of factor A must be homogeneous, and the covariance terms of the common variance-covariance matrix must be equal. The last condition is known as the assumption of circularity. These two assumptions were tested via the procedures described in Winer (29:515-517). Because these procedures involve complex equations and tedious matrix calculation they will not be discussed, however, the calculations will be shown in the next chapter.

The results of these test indicate that the variance-covariance matrices do not meet the homogeneity and circularity criteria. "If the usual F is used and the assumptions have been violated, a positive bias results an the analysis of variance hypothesis will be rejected more often than the true state of affairs warrants for the nominal level of significance" (29:520). In this situation, Winer recommends using a more conservative F test. Table 8 indicates the usual test and the more conservative test used in the analysis.

Table 8. F Ratio Critical Values

F Ratio		Critical Value Test
$\dfrac{MS_b}{MS_{B \text{ x subject within group}}}$	Usual	$F_{1-\alpha}[(b-1), a(n-1)(b-1)]$
	Conservative	$F_{1-\alpha}[1, a(n-1)]$
$\dfrac{MS_{ab}}{MS_{B \text{ x subject within group}}}$	Usual	$F_{1-\alpha}[(a-1)(b-1), a(n-1)(b-1)]$
	Conservative	$F_{1-\alpha}[(a-1), a(n-1)]$
$\dfrac{MS_c}{MS_{C \text{ x subject within group}}}$	Usual	$F_{1-\alpha}[(c-1), a(n-1)(c-1)]$
	Conservative	$F_{1-\alpha}[1, a(n-1)]$
$\dfrac{MS_{ac}}{MS_{C \text{ x subject within group}}}$	Usual	$F_{1-\alpha}[(a-1)(c-1), a(n-1)(c-1)]$
	Conservative	$F_{1-\alpha}[(a-1), a(n-1)]$
$\dfrac{MS_{bc}}{MS_{BC \text{ x subject within group}}}$	Usual	$F_{1-\alpha}[(b-1)(c-1), a(n-1)(b-1)(c-1)]$
	Conservative	$F_{1-\alpha}[1, a(n-1)]$
$\dfrac{MS_{abc}}{MS_{BC \text{ x subject within group}}}$	Usual	$F_{1-\alpha}[(a-1)(b-1)(c-1), a(n-1)(b-1)(c-1)]$
	Conservative	$F_{1-\alpha}[(a-1), a(n-1)]$

The level of significance was set at .05 for all test. If a p-value was obtained which was less than or equal the stated level significance the null hypothesis was rejected with a level of confidence of 95 percent.

The following example will show the computational procedures used for the Multifactor ANOVA with Repeated Measures. "With the exception of the breakdown of the within-cell variation, the computational procedures are identical to those of an a x b x

c factorial experiment having n observations per cell" (16:546). The computational procedures will be illustrated through an example analysis of a 2 x 3 x 3 factorial experiment with repeated on the last two factors given to 6 subjects. This example was developed by Winer and uses the data in Table 9.

Table 9. Basic Data for Numerical Example.

		b1			b2			b3			
	Subjects	c1	c2	c3	c1	c2	c3	c1	c2	c3	Total
a1	1	45	53	60	40	52	57	28	37	46	418
	2	35	41	50	30	37	47	25	32	41	338
	3	60	65	75	58	54	70	40	47	50	519
a2	4	50	48	61	25	34	51	16	23	35	343
	5	42	45	55	30	37	43	22	27	37	338
	6	56	60	77	40	39	57	31	29	46	435

Group 1 (G1) consists of subjects 1, 2, and 3, and group (G2) consists of subjects 4, 5, and 6. To relate this example to our experiment, assume A is the data-set combination factor, B is the mode of presentation factor, C is the task anchoring factor, and the data is the response time of the subject. For example, subject 3 had response time of 58, 54, and 70 seconds, respectively, when performing the level 3 task at level 2 of the mode of presentation factor.

To aid in the calculation of the sums of squares for the ANOVA table, Winer suggests the following summary tables be created (Table 10).

Table 10. Summary Tables for Numerical Example.

ABC Summary table

	b1			b2			b3		
	c1	c2	c3	c1	c2	c3	c1	c2	c3
a1	140	159	185	128	143	174	93	116	137
a2	148	153	193	95	110	151	69	79	118
Total	288	312	378	223	253	325	162	195	255

AB Summary Table

	b1	b2	b3	Total
a1	484	445	346	1275
a2	494	356	266	1116
Total	978	801	612	2391

AC Summary table

	c1	c2	c3	Total
a1	361	418	496	1275
a2	312	342	462	1116
Total	673	760	958	2391

BC Summary Table

	c1	c2	c3	Total
b1	288	312	378	978
b2	223	253	325	801
b3	162	195	255	612
Total	673	760	958	2391

B x Subj. Within G1 Summary Table

Subject	b1	b2	b3	Total
1	158	149	111	418
2	126	114	98	338
3	200	182	137	519
Total	484	445	346	1275

B x Subj. Within G2 Summary Table

Subject	b1	b2	b3	Total
4	159	110	74	343
5	142	110	86	338
6	193	136	106	435
Total	494	356	266	1116

Table 10. Summary Tables for Numerical Example (continued).

C x Subj. Within G1 Summary Table

Subject	c1	c2	c3	Total
1	113	142	163	418
2	90	110	138	338
3	158	166	195	519
Total	361	418	496	1275

C x Subj. Within G2 Summary Table

Subject	c1	c2	c3	Total
4	91	105	147	343
5	94	109	135	338
6	127	128	180	435
Total	312	342	462	1116

Table 11. ANOVA Table Equations and Numerical Example.

$(1) = G^2 / nabc$	$= (2391)^2 / (3*2*3*3)$	= 105,868.17
$(2) = \sum X^2$	$= 45^2 + 53^2 + 60^2 + \cdots + 29^2 + 46^2$	= 115,793.00
$(3) = \left(\sum A_a^2\right) / nbc$	$= \left(1275^2 + 1116^2\right) / (3*3*3)$	= 106,336.33
$(4) = \left(\sum B_b^2\right) / nac$	$= \left(978^2 + 801^2 + 612^2\right) / (3*2*3)$	= 109,590.50
$(5) = \left(\sum C_c^2\right) / nab$	$= \left(673^2 + 760^2 + 958^2\right) / (3*2*3)$	= 108,238.50
$(6) = \left(\sum \left(AB_{ab}\right)^2\right) / nc$	$= \left(484^2 + 445^2 + \cdots + 266^2\right) / (3*3)$	= 110,391.67
$(7) = \left(\sum \left(AC_{ac}\right)^2\right) / nb$	$= \left(361^2 + 418^2 + \cdots + 462^2\right) / (3*3)$	= 108,757.00
$(8) = \left(\sum \left(BC_{bc}\right)^2\right) / na$	$= \left(288^2 + 312^2 + \cdots + 255^2\right) / (3*2)$	= 111,971.50
$(9) = \left(\sum \left(ABC_{abc}\right)^2\right) / n$	$= \left(140^2 + 159^2 + \cdots + 118^2\right) / 3$	= 112,834.33
$(10) = \left(\sum P_m^2\right) / bc$	$= \left(418^2 + 338^2 + \cdots + 435^2\right) / (3*3)$	= 108,827.44
$(11) = \left(\sum \left(BP_{bm}\right)^2\right) / c$	$= \left(158^2 + 149^2 + \cdots + 106^2\right) / 3$	= 113,117.67
$(12) = \left(\sum \left(CP_{cm}\right)^2\right) / b$	$= \left(113^2 + 142^2 + \cdots + 180^2\right) / 3$	= 111,353.67

Using the values from the summary tables in the 12 equations in Table 11 can be easily computed. These 12 equations provide the basis for calculating the sums of squares for the ANOVA table. Table 12 shows how to calculate the appropriate sums of squares by algebraically combining the results of various equations from Table 11.

Table 12. Sums of Squares Calculations.

Source of Variation	Computation Formula	SS
Between Subjects	(10)-(1)	2959.27
A	(3)-(1)	468.16
Subject within groups [error (a)]	(10)-(3)	2941.11
Within subjects	(2)-(10)	6965.56
B	(4)-(1)	3722.33
AB	(6)-(3)-(4)+(1)	333.00
B x subject within groups [error (b)]	(11)-(6)-(10)+(3)	234.89
C	(5)-(1)	2370.33
AC	(7)-(3)-(5)+(1)	50.34
C x subject within groups [error (c)]	(12)-(7)-(10)+(3)	105.56
BC	(8)-(4)-(5)+(1)	10.67
ABC	(9)-(6)-(7)-(8)+(3)+(4)+(5)-(1)	11.32
BC x subjects within groups [error (bc)]	(2)-(9)-(11)-(12)+(6)+(7)+(10)-(3)	127.11

The sums of squares from Table 12 are used to calculate the Mean Squares in the ANOVA table. The Mean Squares are then used to form the F ratios to test the

hypothesis that $\sigma_\alpha^2 = \sigma_\beta^2 = \sigma_\gamma^2 = \sigma_{\alpha\beta}^2 = \sigma_{\alpha\gamma}^2 = \sigma_{\beta\gamma}^2 = \sigma_{\alpha\beta\gamma}^2 = 0$. Table 13 presents the summary ANOVA table for the example data. Significant F ratios are emphasized with asterisks.

Table 13. Summary of Analysis of Variance.

Source of Variation	SS	df	MS	F
Between Subjects	2959.27	5		
A	468.16	1	468.16	0.75
Subject within groups [error (a)]	2941.11	4	622.78	
Within subjects	6965.56	48		
B	3722.33	2	1861.16	63.39*
AB	333.00	2	166.50	5.67*
B x subject within groups [error (b)]	234.89	8	29.36	
C	2370.33	2	1185.16	89.78*
AC	50.34	2	25.17	1.91
C x subject within groups [error (c)]	105.56	8	13.20	
BC	10.67	4	2.67	0.34
ABC	11.32	4	2.83	0.36
BC x subjects within groups [error (bc)]	127.11	16	7.94	

This ANOVA tables shows that the main effects of factors B and C are significant. The AB interaction effect is also shown to be significant. Again, these computational procedures will be used to perform the variance analysis of the experiment.

Neter, Wassermann and, and Kutner (16:634) provide a method for determining the power of an F test. The Power is the probability that the null hypothesis (Ho) is rejected when the alternative hypothesis (Ha) is true. Neter, Wassermann and, and Kutner state

that the power of the F test is the probability that $F^* > F(1 - \alpha; r - 1; n - r)/\phi$, where ϕ is the non-centrality parameter, a measure of how unequal the μ_i are, defined by:

$$\phi = \frac{1}{\sigma}\sqrt{\frac{n}{r}\Sigma\left(\mu_i - \mu\right)^2} \tag{4}$$

where:

$$\mu = \frac{\Sigma \mu_i}{r}. \tag{5}$$

To determine the power probabilities requires the use of the Pearson-Hartley charts provided by Neter, Wassermann and, and Kutner (16). These charts contain several power curves for the F test. Determination of the power of the F test from these charts requires the following parameters: degrees of freedom for the numerator and denominator, level of significance, and the non-centrality parameter. The power of the F tests used for the analysis of variance in this thesis are above 99 percent. Calculations for the power test are located in Appendix F.

If the analysis of variance returns a significant finding, the next step in the statistical analysis is to perform a comparison of means. The Tukey method was used for all "pairwise comparisons of factor level means; in other words, the family consists of estimates of all pairs" (16:580). The Tukey method requires a family confidence coefficient of $1-\alpha$ which makes the confidence coefficient for the each pairwise test larger than $1-\alpha$. The Tukey method for contrast of treatment means utilizes the studentized range distribution (q). The contrast have the following form when there is significant three level interaction:

$$\hat{L} \pm Ts\{\hat{L}\} \tag{6}$$

where:

$$\hat{L} = \sum\sum\sum c_{abc}\mu_{abc} \text{ and } \sum\sum\sum c_{abc} = 0 \tag{7}$$

$$s^2\{\hat{L}\} = \frac{MSE}{n}\sum\sum\sum c_{abc}^2 \tag{8}$$

$$T = \frac{1}{\sqrt{2}} q[1 - \alpha, r, \text{df of MSE}]. \tag{9}$$

In Equations (6) - (9), r is the number of comparisons being made and c is a matrix of positive and negative ones arranged in a manner that all pairwise comparisons of treatment means can be made. Finally, in a repeated measures experiment the error is partitioned into different components. It is important that the appropriate error term be used. From Table 13, the error for three way interaction is MSBC x subjects within groups [error (bc)]. Thus, MSBC x subjects within groups would be used instead of MSE in this case.

Equations (6) - (9) are used when there is significant three way interaction. However, there may be cases when there only two-way interactions which involve taking the means of mabc over one of the factors. For example, take the case when there are only BC interactions, then there is only interest in contrast of the m.bc means. In this special case the estimator and estimated variance for contrast of the treatment have the following form:

$$\hat{L} = \sum\sum c_{bc}\mu_{bc} \text{ and } \sum\sum c_{bc} = 0 \tag{10}$$

$$s^2\{\hat{L}\} = \frac{MSE}{na}\sum\sum c_{bc}^2. \tag{11}$$

Again MSBC x subjects within groups would be used instead of MSE in this case. Choosing the correct error term for the contrast of means is a relatively simple task. However, care must be taken when the comparison being made are between subjects groups. For example, $\mu_{1b.} - \mu_{2b.}$ has a estimated variance composed of both between

subject group and within subject group error. The estimated variance has the following form:

$$s^2(\hat{L}) = \frac{SS_{\text{subject within groups}} + SS_{\text{B x subject within group}}}{nc[a(n-1)+a(n-1)(b-1)]} \Sigma\Sigma c_{ab}^2 . \quad (12)$$

On the other hand, $\mu_{a1.} - \mu_{a2.}$ has an estimated variance composed of only error associated with factor B,

$$s^2(\hat{L}) = \frac{MS_{\text{B x subject within group}}}{nc} \Sigma\Sigma c_{ab}^2 . \quad (13)$$

The final area of the statistical analysis was accomplished on the accuracy scores. Because of the dichotomous nature of the accuracy scores based on the frequency count of correct answers, the Chi-squared statistic was use to analyze the data. The Chi-squared statistic was applied to a contingency table that shows the observed frequencies for each treatment. According to Shao "this type of test will tell us whether or not the two basis of classification used respectively in rows and columns of a contingency table are independent (or not related) (19:428)." The Statistix software package was used for this analysis. If the calculated Chi-squared statistic is significant enough to reject the null hypothesis, then a cell by cell comparison of the proportions is utilized to identify where there are significant differences.

Characteristics of Sound Measurement

Emory states that there are three major considerations researchers should use in evaluating a measurement tool. They are validity, reliability and practicality (11:179).

> Validity refers to the extent to which a test measures what we actually wish to measure. Reliability has to do with the accuracy and precision of measurement procedure. . . . . Practicality is

concerned with a wide range of factors of economy, convenience, and interpretability. (11:179)

There are two major varieties of validity, external and internal, to be considered. Internal validity is concerned with the conclusions drawn from an experiment, and if there is a causal relationship. External validity is concerned with the observed causal relationship and if this relationship is generalizable across persons, settings and times (11:424).

Internal Validity. Internal validity is also the ability of a research instrument to measure what it is suppose to measure. The seven major threats to internal validity are as follows (11:424-425):

(1) History - events might occur that may confound the effects of the experiment and confuse the relationship being studied.

(2) Maturation - a concern when the experiment is run for or over a long period of time, but may also be a factor for short experiments. Changes may take place with the subjects taking the experiment that are not specific to any particular event.

(3) Testing - taking multiple tests can have a learning effect which influences the results of subsequent testing.

(4) Instrumentation - a threat that results from changes between observations, in the measuring instrument or the observer.

(5) Selection - the specified selection of subjects to experimental and control groups. Validity consideration requires that experimental and control groups be equivalent in every respect.

(6) Statistical Regression - research groups have been selected based on previous scores which may be extreme.

(7) Experiment Mortality - a problem occurs when the composition of the original research groups change during the experiment.

These seven threats are generally, but not always, adequately dealt with in randomized experiments (11:426). This experiment used a randomized order within-

subject factorial design with repeated measures. The seven major threats to internal validity were considered during the construction of the experiment.

History was not a threat consideration because each subject was only tested once, in a computer laboratory with a maximum of fifteen participants. Each subject took no longer than fifteen minutes to complete the experiment. Subjects were given direction prior to the experiment only, and had no prior knowledge of the test and its associated objectives. Participants did not leave the computer laboratory until after they had completed the experiment. If there were any historical events that may have occurred, each participant was subjected to the same event.

Maturation was not a factor, first, because the subjects participated on only a voluntary basis. Second, the length of the test was a maximum of fifteen minutes. Third, the subjects participated in the experiment either in the early morning or shortly after lunch and should not have been tired nor hungry. Fourth, they were told upfront there would be a maximum of twenty-five graphic questions and seventeen demographic questions. Therefore they did not have to speculate on the number of questions or on the length of the test. This should have helped preclude boredom. Finally, in the end-of exercise questionnaire section (seventeen demographic questions), the subjects were asked what their level of interest was in the experiment. Ninety-seven percent of the responses ranged from moderate (level 4) to very high (level 7).

Testing was not a consideration because each of the 64 subjects participated in the experiment only once in the same computer laboratory environment. Therefore, there was no learning effect from taking multiple tests.

Instrumentation should not be a threat consideration because each of the experiments was conducted on the same type of 386 microcomputer using a Quattro Pro graphics software package, in the same laboratory environment, with the same two monitors.

Selection should also not be a factor because, each of the subjects were randomly assigned to each computer terminal and given the same twenty-five graphs to analyze and respond to. The graphs, with the various treatment combinations, for each participant, were randomly ordered by the computer software. "If subjects are randomly assigned to experimental and control groups, this selection problem can be largely overcome" (11:425).

Statistical Regression was not a threat consideration because the participants were only tested once in the same environment and had not been pre-selected based on previous scores on the test.

Experiment Mortality was not a consideration because each of the subjects were volunteers who participated in an experiment with a maximum length of fifteen minutes only once. Therefore, the composition of the research group did not change.

External Validity. "External validity is concerned with the interaction of the experimental stimulus with other factors and the resulting impact on abilities to generalize to (and across) times, settings, or persons" (11:427). The three major threats to external validity are as follows (11:427-428):

(1) Reactivity of Testing on X - sensitizing subjects during the pretest, so they respond differently when they are given the actual experiment.

(2) Interaction of Selection and X - the population the participants are selected from may not be the population to which results are to be generalized.

(3) Other Reactive Factors - the experimental setting may have a biasing effect on the subjects responses. The experimental setting may not be realistic or representative of the actual setting of the generalized population. If the subjects are aware there is an experiment being conducted, they may role-play to distort the effects.

"Problems of internal validity are amenable to solution by the careful design of experiments, but this is less true for external validity" (11:428). External validity is mainly

generalization, and is an inductive process of extrapolating beyond the actual data collected (11:428).

Reactivity of Testing on X was not a threat consideration because an experimental pretest was not conducted.

Interaction of Selection and X was reduced by randomly assigning the voluntary participants to the two data-set combinations incorporating the associating treatment level combinations. AFIT Professional Continuing Education (PCE) students volunteered to participate in this study. PCE students were chosen because of their broad and diverse backgrounds. Question 15 in the end-of exercise questionnaire asked which areas they considered to be the primary basis for their professional experience. The subjects were experienced in the following areas: technical, scientific, engineering, operational, financial, managerial, contracting, and logistics. The experiment is trying to determine the affect of graphics on the decision maker. The backgrounds associated with the subjects all require decision-making at various level. Therefore, the results of the experiment should be applicable to the generalized population of managers, leaders and decision makers.

The Other Reactive Factors were controlled by placing the experiment on a microcomputer. Although the subjects realized they were participating in an experiment, they did not realize the time to complete each of the graphs was being automatically recorded. Therefore, they did not feel encouraged to compete against the clock. The subjects were also observed to ensure they diligently worked through the experiment and were not distracted. The monitors observed no distracted behavior. To relieve any anxiety the participants may have had working on a computer, the experiment was automated to the full extent possible. The subjects entered their response by pressing the corresponding number key on the keyboard (no mouse was used). If they type a number other than in the correct range, then they were given another chance to respond appropriately. After they entered an appropriate response, the computer displayed the

next graph and question. This procedure greatly reduced the subjects anxiety that they may do something wrong.

Reliability. "A measure is reliable to the degree that it supplies consistent results. Reliability is a contributor to validity and is a necessary but not sufficient condition for validity" (11:185). Reliability is concerned with estimates in which a measurement is free of random error. Reliable instruments are robust because they work well at different times and under different conditions. The three perspectives that are typically used to measure reliability are as follows (11:185-186):

(1) Stability - occurs if you can obtain consistent results with repeated measurements of the same person with the same instrument. Stability measurements are more difficult and not as beneficial in survey situations as for observation studies. Stability is concerned with personal and situational fluctuations from one time to another.

(2) Equivalence - considers how much error may be introduced by different observers or different samples of items being studied. Equivalence is concerned with variations at one point in time among observers and samples of items. If subjects are classified the same way by each test, then the tests are said to have good equivalence.

(3) Internal Consistency - this approach uses only one administration of an instrument or test to determine consistency or homogeneity among the items. Techniques such as the split-half can be used to determine if the similar questions and statements to both halves have similar responses and if there is a correlation.

The perspective of stability cannot be used to measure reliability because repeated measurements cannot realistically be obtained. Due to the limited time frame allocated for this thesis process (10 months) and the various DoD resources (PCE students) used in the experiment, a duplication of this effort is practically impossible. Also, the longer the time span between tests, the greater the chance outside factors will contaminate the measurement and distort the stability. Because of this fact, more interest has been focused on equivalence (11:186).

The equivalence perspective measures the degree to which alternative forms of the same measure produce same or similar results (11:188). The test for item sample equivalence uses alternative or parallel forms of the same test that is administered to the same person simultaneously (11:186). Alternate or parallel forms of the test were not administered simultaneously to the participants; however, each participant did observe all twenty-five graphs. Therefore, subjects were classified the same way for each test.

Internal consistency measures the degree to which instrument items are homogeneous and reflect the same underlying construct (11:188). Each of the participants was randomly assigned to identical 386 microcomputers with identical Quattro Pro software packages. Although, the order of the graphics was randomly assigned for each participant, each participant observed the exact same twenty-five graphs. Because the response times and accuracy measurements were recorded by the computer, each of the participants were measured exactly the same. Additionally, the same two monitors were present for all computer laboratory experiments. To eliminate the source of bias between different individuals, a within-subject factorial design with repeated measures was also used (this design was explained previously).

Practicality. The scientific requirements of an experiment direct the measurement process to be reliable and valid; however, the operational requirements demand the test to be practical (11:189). Thorndike and Hagen define practicality in terms of economy, convenience, and interpretability, with respect to the development of educational and psychological tests (24:199).

(1) Economy - tradeoffs are typically required between the ideal research experiment and an experiment that is affordable. Areas that need to be considered for economy are the instrument length, and the choice of the data collection method.

(2) Convenience - a measuring device passes the convenience test if it is easy to administer. Areas that need to be considered are the instructions associated with the experiment, and the layout of the measuring instrument.

(3) Interpretability - documented experimental procedure information is necessary so other researchers will be able to adequately assess your results.

Economy was considered in the experiment by using the within-subject factorial design with repeated measures. Of course this was not the primary reason for the choice of the design; however, this design does reduce the number of participants required for the experiment. Also, the AFIT computer laboratories, with the required 386 microcomputer and the Quattro Pro software package were both available and easily accessible. By using a computer to automatically record the results of the experiment, this eliminated the costs associated with written and telephone surveys.

This experiment was convenient and extremely easy to administer. The task complexity of the experiment was kept simple. Precise verbal and written instructions were given to all participants. To relieve any anxiety the participants may have had working on a computer, the experiment was automated to the full extent possible. The subjects entered their response by pressing the corresponding number key on the keyboard (no mouse was used). Because the results were automatically recorded into a spreadsheet, the accuracy and response time data were easy to manipulate.

The experiment is easy to interpret and the documented Quattro Pro program as well as the actual experiment is included in Appendices B and A, respectively. This will allow additional research to be conducted that is above and beyond the objectives of this thesis. To replicate this experiment, researchers would need to use the same measurement questions, same presentation format, same underlying data and so on.

Construction of the Experiment

The taxonomy developed by Tan and Benbasat described in the literature review for characterizing graphs and tasks was used in constructing the experiment. The taxonomy for graphs will be examined to see if it is an accurate method for identifying which graphical format is appropriate for a given task (investigative question eight). The taxonomy for task will be used to examine whether or not there are any elementary data collection tasks that three-dimensional graphs facilitate more accurate solutions than two-dimensional graphs and tables (investigative question six).

The first step in constructing the experiment was to identify the graphs and questions to be used. The experiment consisted of time-series graphs that depicted financial information for four regions (North, South, East, and West) over seven periods. This information was presented in five different presentation modes: table, two-dimensional bar, two-dimensional line, three-dimensional bar, and three-dimensional line. The experimental package is provided in Appendix A. Each graph was developed in strict accordance with the criteria for high integrity graphics. A common software package (Quattro Pro for Windows) was used to generate the graphs. The Quattro Pro default graphical format was maintained except when it contradicted the criteria for high integrity graphics. Twenty-five graphs which consisted of twenty legitimate graphs and five masking graphs were developed for the experiment.

The second step in constructing the experiment was to identify the task questions to be used. Tan and Benbasat suggest that:

> There are four basic types of information anchoring conditions that characterize data extraction task for two-dimensional graphics with one or more instances of the same entity: (1) high x-value, high y-value anchoring; (2) high x-value, low y-value anchoring; (3) low x-value, high y-value anchoring; (4) low x-value, low y-value anchoring. (22:172)

Each of these conditions will be represented by the task questions used in the experiment. The questions will be used to measure how well the various modes of graphical presentation facilitate accurate solutions to elementary data collection tasks (investigative question three).

The last step in constructing the experiment was to determine the seventeen measurement questions for the follow-up survey. The purpose of the follow-up survey is to obtain background information on the participants and to examine any pertinent opinions the participants may have.

Experimental Item

A copy of the experimental item (graphs/ charts) is located in Appendix A. Appendix B contains the end-of-exercise questionnaire. The associated macros and code for the design of the experiment are located in Appendix C.

Experimental Procedures

Sixty-two AFIT Professional Continuing Education (PCE) students volunteered to participate in this study. To maintain a balanced design, thirty-one students were randomly assigned to each of the data-set combinations.

The experiment was administered with a microcomputer. The software package Quattro Pro for Windows was used to generate, automate and present the twenty-five graphical displays. Every effort was made to ensure the displays met the criteria establish by Tufte [25]. Subjects who volunteered for the experiment participated in groups of ten to fifteen students in a computer laboratory. When participants arrived at the computer laboratory, they were asked to sit down at a computer terminal and wait for instructions. The experiment was already loaded on each computer terminal. When everyone arrived, the subjects were given the following instructions:

> You will be reviewing twenty-five graphical displays of financial data, and each display contains a multiple choice question. Your task is to answer each question as best you can using the information provided in the graph. Because all of the questions have four possible responses (1, 2, 3, or 4), enter your response by pressing the corresponding number key on the keyboard . Should you type a number other than one through four you will be given another chance to respond appropriately. After you have entered an appropriate response, the computer will display the next graph and question. When you have completed all twenty-five graphs you will be asked a series of seventeen demographic questions. Once you have completed the experiment you are free to leave. If there are no questions, please proceed at your own pace.

Although the students observed twenty-five graphs, measurements were only taken from twenty. The additional five graphs were used to help disguise the use of the same two data-sets in a given data-set combination.

End-of Exercise Questionnaire

Following the twenty-five graphs an end-of exercise questionnaire containing seventeen questions and statements were asked. The participants were told that the questions and statements concerned: (1) the experiment they had just completed, (2) their level of experience with graphs, and (3) their background information for demographic purposes.

The reason for the use of a questionnaire is based on previous research findings that some perceptual and demographic characteristics are significant in graphical presentation preferences and interpretation (4:54; 3:68). The questionnaire allowed additional research to be performed to determine if the participants characteristics affected the decision-making process.

The first five questions related directly to the experiment the participants had just completed. These questions were designed to allow a greater understanding of problems or difficulties participants may have experienced during the test. The experiment was designed with simple task complexity, and these questions aided our understanding of the effort involved in extracting and assessing data in the experiment. Three of the questions

(1, 4, and 5) used a seven-point Likert scale anchored with well defined incremental levels ranging from strongly disagree to strongly agree. These questions were used to determine if the information and questions were easy to understand and if the charts contained too much information. "A person's ability to hold only seven items in immediate memory for comparison purposes has been labeled span of absolute judgment" (6:28). This small span of absolute judgment creates a need to group data. Therefore, it is important that report formats use groupings that assist the memory input process and do not overload the decision maker (6:28). Questions 2 and 3 listed the five modes of presentation; tables, 2D bar charts, 2D line charts, 3D bar charts, 3d line charts. The responses to these questions were used to determine which of the five modes of presentation used in the experiment, were believed to be the most useful for identifying and comparing regional information.

Questions 6 and 7 were used to identify the presentation format the participants preferred for the presentation of information, and to identify the level of interest in the experiment itself. Question 6 included the five modes of presentation as well as an "other" category to select from. Question 7 used a seven-point Likert scale anchored with well defined incremental levels ranging from very low to very high.

Questions 9 through 11 were designed to assess the level of experience with graphs, and to assess how often the participants constructed and used graphs for and in decision-making, respectively. People can better interpret data in graphics they are familiar with. This familiarity is important because it could have an effect on the accuracy and response time measurements obtained in the experiment. The selected responses (8 levels) ranged from daily use and construction of graphs to never using or constructing graphs. Question 10 assessed the level of graphics training, in either construction or interpretation, the participants have previously received. Although there were 7 levels to select from, there were three basic categories for training; formal, informal and no training. The participants who have received training may have an advantage in the interpretation of the graphics.

Questions 8 and 12 through 17 requested demographic data. Because we used a colorized experiment (the colors were kept constant for every graph and participant and was not considered a factor), it was necessary to determine if any of the subjects were color blind (Question 8), and to see if this limitation affected the accuracy and response time measurements. The sex of the participant was of interest (Question 12), because in the past gender was found to be a significant factor in graphical interpretation. The rank and education background of the subjects (Questions 13 and 14) were necessary to determine the level of managerial experience. Typically, the more educated and higher ranked the subjects are, the greater their decision-making experience. Also, the greater their decision-making experience, the greater their breadth in analyzing and interpreting the various modes of presentation. Questions 15 through 17 were used to determine the different areas and associated years of professional experience. This is necessary to ensure the participants are representative of a generalizable population and in decision-making positions.

The use of the computer significantly enhanced the administration of the experiment. First, the computer randomized the sequence of graphical displays presented to each subject. Another benefit is that the computer unobtrusively measured the time of each subject's response. Finally, the software was coded to record each subject's response and response time. When the experiment was completed the results were printed to a text file. This data transfer allowed the experimental data to be easily imported into the statistical software package that was used to analyze experimental results.

Conclusion

An experiment was written to test when it is more appropriate to present information in a three-dimensional graph than in a two-dimensional graph or table. The experiment was formulated using a 5 x 4 x 2 full-factorial, within-subject design. The experiment

consisted of graphs in five different presentation modes: tables, two-dimensional line, two-dimensional bar, three-dimensional line, and three-dimensional bar. By comparing how well Air Force decision makers perform elementary data collection tasks for each mode of presentation, the experiment tested whether three-dimensional graphs are more accurate and efficient than two-dimensional graphs and tables. A t-test on the differences in two means will be the statistic used in the experimental analysis.

Chapter IV, Analysis and Findings, will contain the results of the experiment, and will address investigative questions three, four and five. Chapter V, Conclusion, will summarize the results of the study and will discuss investigative questions six, seven, and eight.

IV. Analysis and Findings

Introduction

This study used a 2 x 5 x 4 [Data-set combination (A) x Mode of Presentation (B) x Task Anchoring Level (C)] factorial experiment in which there are repeated measure on the last two factors. There are 31 subjects in each data-set combination group. Each subject is observed under all bc combinations of factors B (mode) and C (task), but only under a single level of factor A (data-set combination). Thus, there are two groups of 31 subjects each (62 subjects in all) and there are bc (20) observations of each subject. These two groups were used to test the six hypotheses identified early in Chapter 3. The third, four and fifth investigative questions are addressed in this chapter.

This chapter presents the data obtained from the research and an analysis of the experimental results and findings. The chapter is divided into three main sections. The first section discusses seven tests that were conducted to test for the main effects associated with factors A, B, and C, and their interactive effects. Section one was partitioned into two categories: Accuracy and Time Performance. These two sub-sections will answer investigative questions three and four, respectively. Section two, which addresses investigative question five, describes the demographic analysis, and discusses those demographic characteristics that have an effect on the subject's response time. Finally, the last section summarizes the chapter.

Experimental Analysis and Findings

Appendices D - G contain the overall results of the experimental data. Appendix D contains the raw data (for 62 subjects) which includes the accuracy and time response data for each of the 20 graphs/charts, as well as the seventeen end-of-exercise questionnaire responses. Appendix E consists of the natural logarithm transformation tables of the response times that were used for statistical analyses. Appendix F includes the power test

calculations and the variance-covariance matrix information required to test for the homogeneity and equality assumptions to be discussed later. Appendix G contains the repeated measures calculations for the various ANOVA tables included in this chapter.

There were seven main tests conducted in the analysis of the experiment. Tests 1 and 2 were conducted to test for the main effects associated with the factors, mode of presentation (B) and task anchoring (C), respectively. Tests 1 and 2 tested for treatment mean differences, for both factors, as they relate to both subject response time and response accuracy. Test 3 was conducted to test for the main effect of the factor data-set combination (A). Tests 1 - 3 are followed by Tests 4 - 7, which test for factor interaction among factors A, B, and C.

The analysis for these seven tests are described in the next two sections, Accuracy and Time Performance. The Accuracy section discusses the Chi-square analysis for accuracy based on the frequency of correct responses for the treatment combinations of task anchoring and mode of presentation. The Time Performance section explains the multifactor ANOVA with repeated measures analysis of the response time, and the Tukey method of multiple comparisons.

Tests 1 - 7 and their associated hypotheses are described as follows:

Test 1: Test for main effects associated with the factor, mode of presentation. The experimental hypotheses for Test 1 were:

(1a) H_o: No difference exists between the mode of presentation treatment means as they relate to subject response time.

H_a: At least two mode of presentation treatment means differ.

(1b) H_o: No difference exists between the mode of presentation treatment means as they relate to response accuracy.

H_a: At least two mode of presentation treatment means differ.

Test 2: Test for main effects associated with the factor, task anchoring. The experimental hypotheses for Test 2 were:

(2a) H_0: No difference exists between the task anchoring treatment means as they relate to subject response time.

H_a: At least two task anchoring treatment means differ.

(2b) H_0: No difference exists between the task anchoring treatment means as they relate to response accuracy.

H_a: At least two task anchoring treatment means differ.

Test 3: Test for main effects associated with the factor, data-set combination. The experimental hypothesis for Test 3 was:

(3) H_0: No difference exists between the data-set combination treatment means as they relate to subject response time.

H_a: At least two data-set combination treatment means differ.

Test 4: Test for mode of presentation and task anchoring factor interaction. The experimental hypothesis for Test 4 was:

(4) H_0: The factors mode of presentation and task anchoring do not interact to affect response time means.

H_a: At least two treatment means differ.

Test 5: Test for mode of presentation and data-set combination factor interaction. The experimental hypothesis for Test 5 was:

(5) H_0: The factors mode of presentation and data-set combination do not interact to affect response time means.

H_a: At least two treatment means differ.

Test 6: Test for task anchoring and data-set combination factor interaction. The experimental hypothesis for Test 6 was:

(6) H_0: The factors task anchoring and data-set combination do not interact to affect response time means.

H_a: At least two treatment means differ.

Test 7: Test for mode of presentation, task anchoring, and data-set combination factor interaction. The experimental hypothesis for Test 7 was:

(7) H_0: The factors mode of presentation, task anchoring, and data-set combination do not interact to affect response time means.

H_a: At least two treatment means differ.

Accuracy Analysis. Chi-square analysis for accuracy based on the frequency of correct responses for the treatment combinations of c_1 - c_4 (task anchoring) and b_1 - b_5 (mode of presentation) was conducted combining the two data-set combinations. The results for the Chi-square analysis are displayed in Table 14. These results show that the overall Chi-square statistic is not statistically significant at the .05 level. Therefore, the null hypothesis for Test 1 (1b) and Test 2 (2b) are not rejected. These results indicate that the majority of the subjects achieved a high level of accuracy performance across different modes of presentation and task anchoring levels (b and c). However, the three-dimensional line graph had particularly low accuracy scores for High-High (HH) and Low-Low (LL) task anchoring (bc_{51} and bc_{54}). Figure 4 shows the percentage of correct responses for these two accuracy scores is below 60 percent.

Table 14. Chi-square Analyses for Accuracy Response.

		b1	b2	b3	b4	b5	Total
c1	observed	57	56	54	56	20	243
	expected	51.65	51.43	49.63	50.31	39.98	
	cell Chi-square	0.55	0.41	0.38	0.64	9.98	
c2	observed	62	60	61	60	61	304
	expected	64.62	64.34	62.09	62.94	50.01	
	cell Chi-square	0.11	0.29	0.02	0.14	2.41	
c3	observed	62	61	61	61	60	305
	expected	64.83	64.55	62.30	63.14	50.18	
	cell Chi-square	0.12	0.20	0.03	0.07	1.92	
c4	observed	49	52	45	47	37	230
	expected	48.89	48.68	46.98	47.62	37.84	
	cell Chi-square	0.00	0.23	0.08	0.01	0.02	
	Total	230	229	221	224	178	1082

Overall Chi-square	17.62
P-value	0.13
d.f.	12

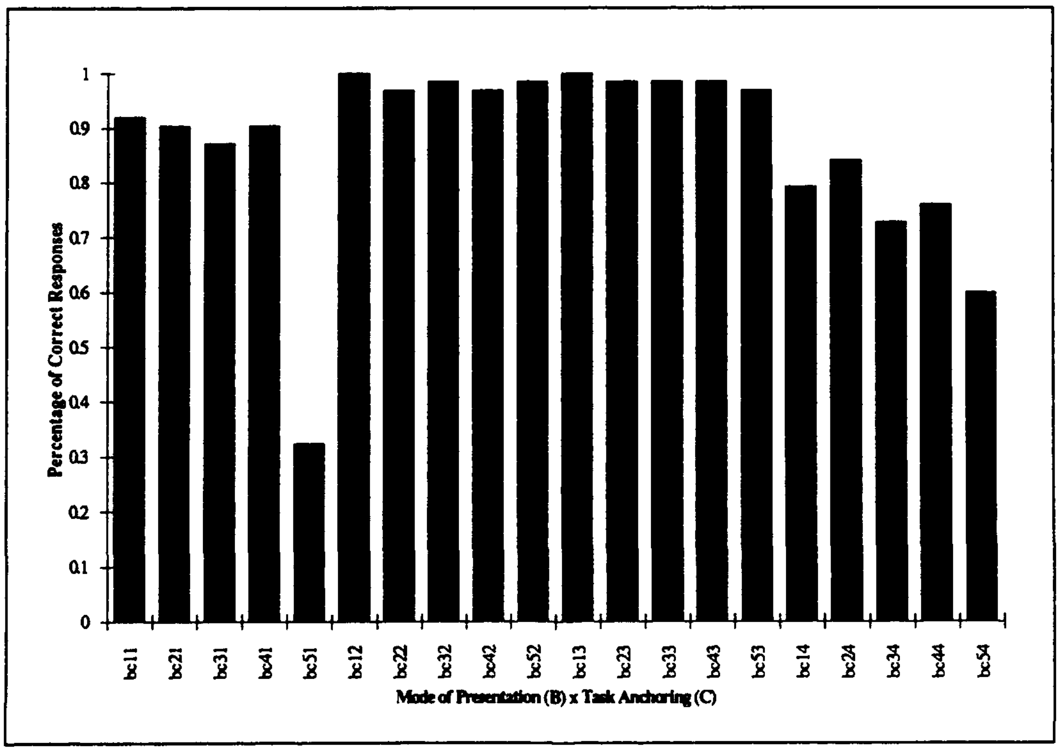


Figure 4. Percentage of Correct Responses.

The reason for the low scores can be attributed to the fact that the three-dimensional line graphs have a tendency to obscure data. For example, Figure 5 shows how the data appeared in the three-dimensional line graph when the subjects were asked to identify the region which had earned $300 in March. Figure 6 is a comparison and shows how the same data appeared in the two-dimensional line graph for the same task. It is obvious from the graph in Figure 6 that the correct response is the East region. In Figure 5, the answer is not obvious because the East region's performance in March is hidden behind the ribbon depicting the West region's performance.

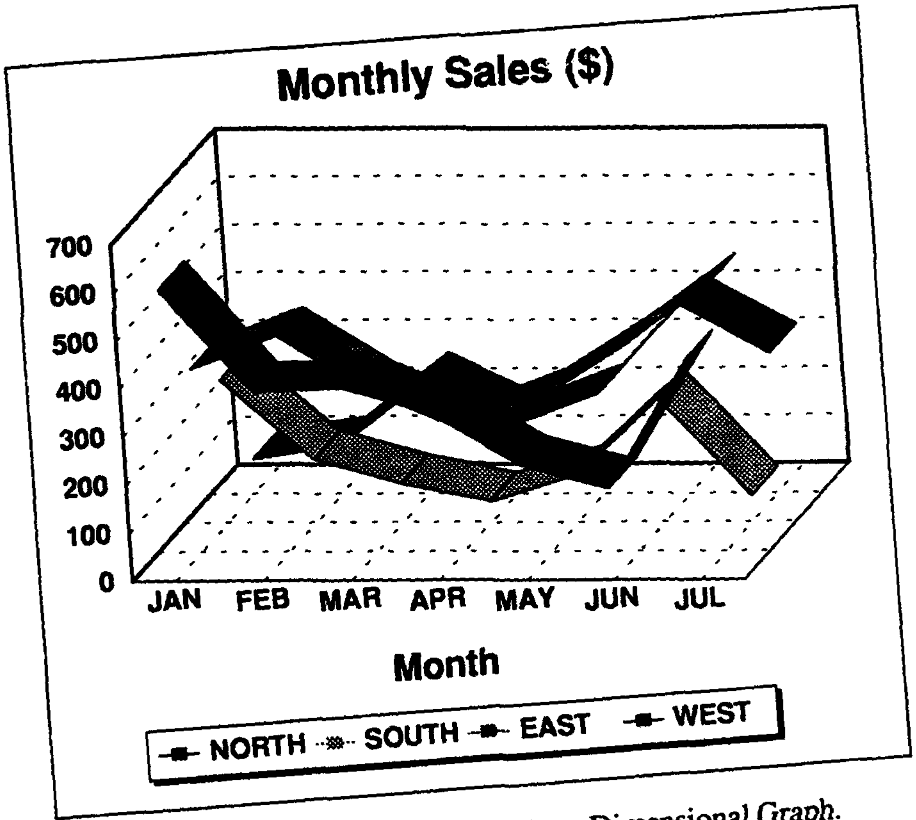


Figure 5. Obscured Data in a Three-Dimensional Graph.

In general, accuracy performance was high for most subjects regardless of the mode of presentation or the task anchoring, thus eliminating time-accuracy tradeoffs as a potential decision criteria for graphical format (investigative question three). Therefore,

the major performance variance among subjects were attributed to time differences required for extracting the relative responses from the graphical presentations.

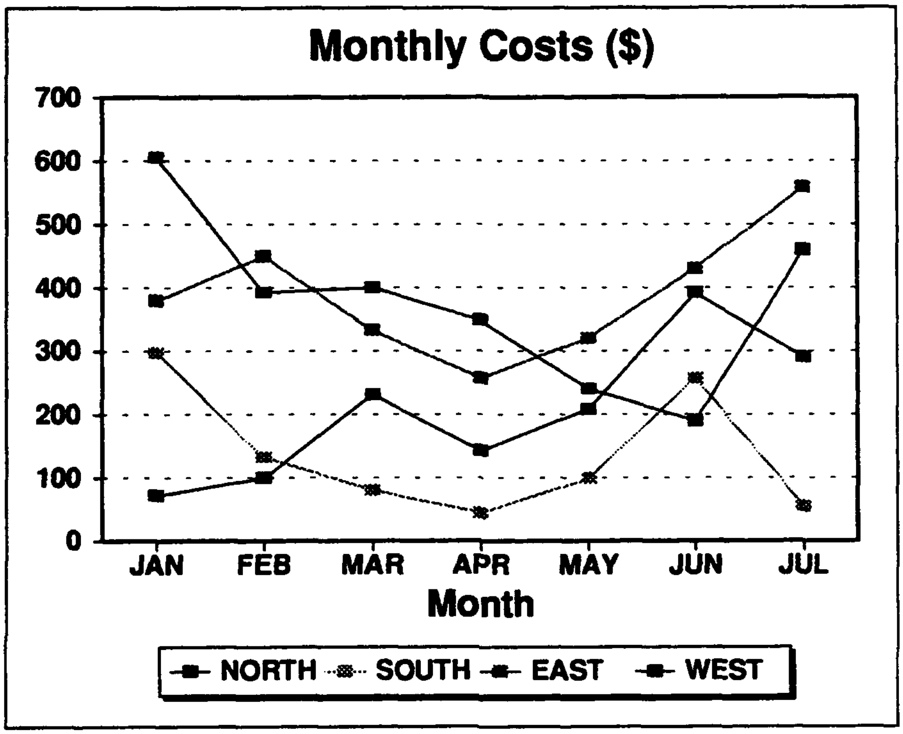


Figure 6. Comparative Two-Dimensional Graph.

Time Performance. As stated in Chapter 4, the validity of the multifactor ANOVA with repeated measures analysis of the response time is based on several assumptions. The first assumption is that the observations represent random samples from the population. This assumption was met by randomly assigning the subjects to the two test groups and randomizing the order in which each subject received the treatments. The second assumption is that the observations are drawn from a normally distributed population. The histogram and normality plot for the response time illustrates that the data does not meet the normality assumption (Figures 7 and 8). A Wilk-Shapiro score above 0.9 and a relatively straight 45 degree line for the Rankit Plot are indications of normality.

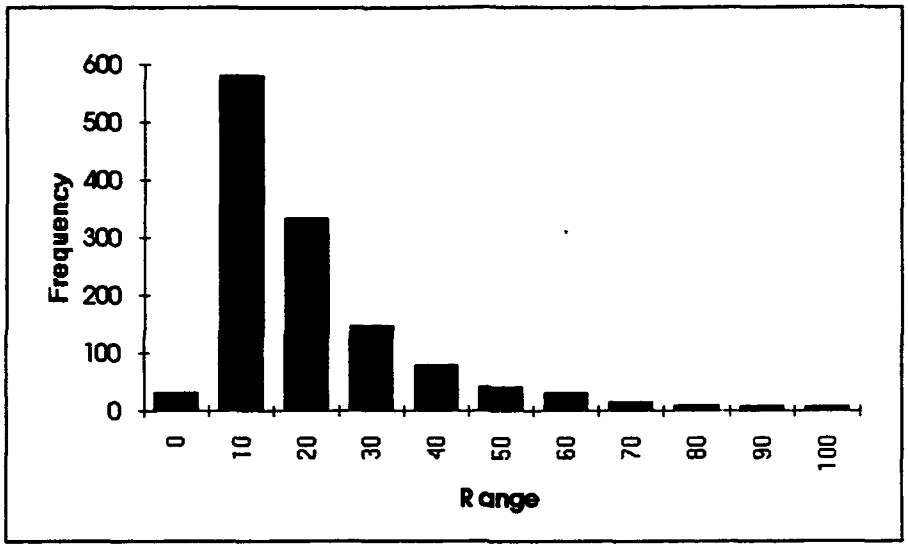


Figure 7. Response Time Histogram.

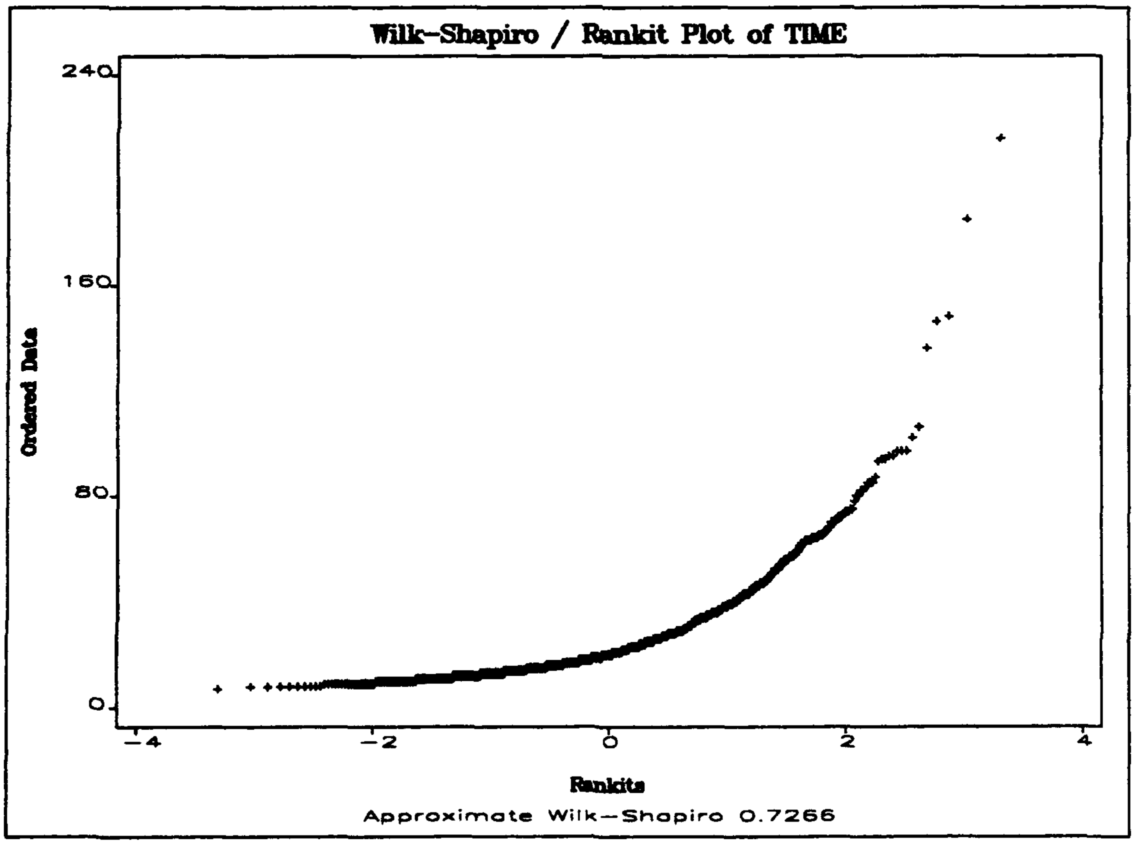


Figure 8. Wilk-Shapiro Normality Plot for Response Time.

To satisfy the normality assumption, the response times were transformed using the natural logarithm (LN). The histogram and normality plot for the LN of the response time illustrate that the data can be assumed to be approximately normal (Figures 9 and 10).

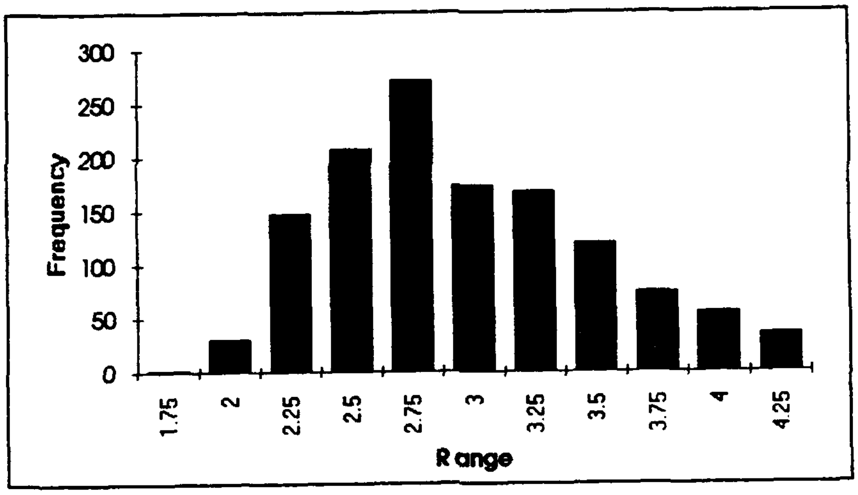


Figure 9. Natural Logarithm of Response Time Histogram.

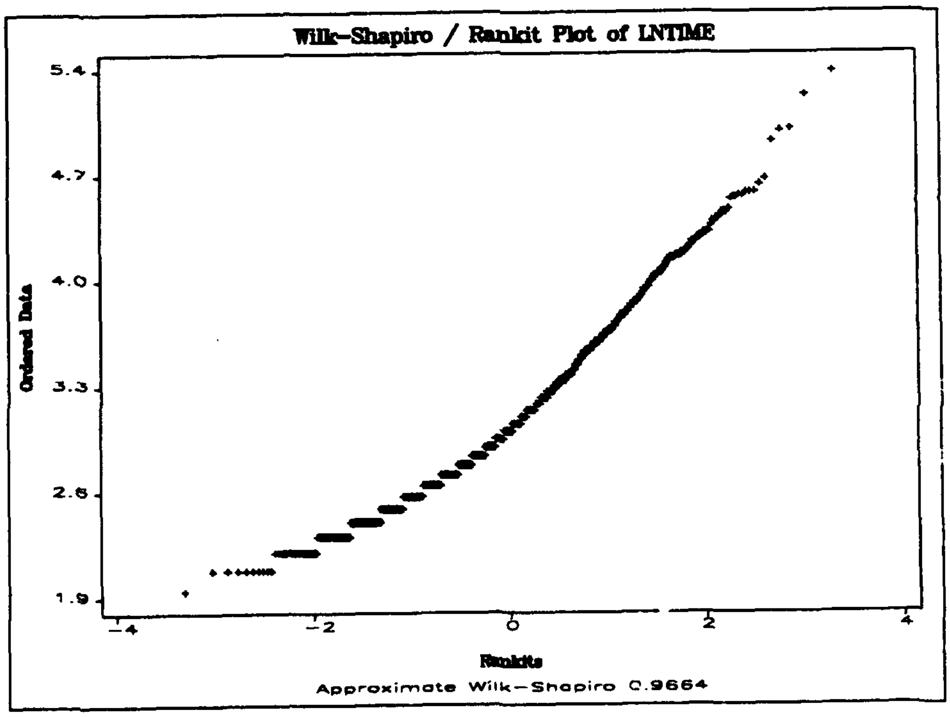


Figure 10. Wilk-Shapiro Normality Plot for the Natural Logarithm of Response Time.

Additional assumptions are "about the form of the variance-covariance matrix associated with the joint multivariate normal distribution of the random variables in the model" (29:517). Specifically, the variance-covariance matrices of factor A must be homogeneous, and the covariance terms of the common variance-covariance matrix must be equal. These two assumptions were tested via the procedures described in Winer (29:515-517). The variance-covariance matrix is located in Appendix F.

Winer states that the statistic for testing the homogeneity of the variance-covariance matrix is:

$$\chi_1^2 = (1 - \mathrm{C}_1)\mathrm{M}_1 \tag{14}$$

where:

$$M_1 = N \ln\left|S_{pooled}\right| - \sum n_i' \ln\left|S_i\right| \tag{15}$$

$$C_1 = \frac{2q^2 + 3q - 1}{6(q+1)(p-1)}\left[\sum\left(\frac{1}{n_i'}\right) - \frac{1}{N}\right]. \tag{16}$$

This statistic has a sampling distribution which is approximated by a Chi-squared distribution having f_1 degrees of freedom:

$$f_1 = \frac{q(q+1)(p-1)}{2}. \tag{17}$$

Appendix F contains the calculations associated with equations (14) - (17) for this experiment. The test statistic, χ_1^2, has a value of 271.18 with 210 degrees of freedom. The p-value for this test is .003, thus, homogeneity of the variance-covariance matrix is rejected at the .05 level of significance.

The assumption of circularity can be tested in a similar manner using the following statistic:

$$\chi_2^2 = (1 - \mathrm{C}_2)\mathrm{M}_2 \tag{18}$$

where:

$$M_2 = -(N-p)\ln\left|\frac{S_{pooled}}{S_0}\right| \tag{19}$$

$$C_2 = \frac{q(q+1)^2(2q-3)}{6(N-p)(q-1)(q^2+q-4)}. \tag{20}$$

This statistic has a sampling distribution which is approximated by a Chi-squared distribution having f_2 degrees of freedom:

$$f_2 = \frac{q^2+q-4}{2}. \tag{21}$$

Appendix F contains the calculations associated with equations (18) - (21) for this experiment. The test statistic, χ_2^2, has a value of 250.61 with 208 degrees of freedom. The p-value for this test is .023, thus, the assumption of circularity for the common variance-covariance matrix is rejected at the .05 level of significance.

The results of these test indicate that the variance-covariance matrices do not meet the homogeneity and circularity criteria. Therefore, the conservative F tests from Table 8 (Chapter 3) are used to determine the significance of factor effects.

Table 15 shows the results of the multifactor ANOVA with repeated measures on the response time. Appendix G contains the calculations that support Table 15. These calculations were accomplished in accordance with the computational procedures described in the statistical analysis section of Chapter 3, significant F ratios are emphasized with asterisks.

Table 15 (ANOVA) shows that the main effects of factors B and C are significant; therefore, the hypotheses 1a and 2a are rejected. The AB and BC interaction effects are also shown to be significant resulting in the rejection of hypotheses 5 and 4, respectively.

Hypotheses 3, 6, and 7 are not rejected because the main effect of factor A and the interaction effects of AC and ABC are insignificant.

Table 15. Summary of Analysis of Variance.

Source of Variation	SS	df	MS	Fcrit	F
Between Subjects	56.2	61			
A [Data]	0.3	1	0.3	4.0	0.353
Subject within groups [error (a)]	55.9	60	0.9		
Within subjects	302.9	1178			
B [Mode]	2.6	4	0.6	4.0	5.033*
AB [Data*Mode]	3.4	4	0.9	4.0	6.683*
B x subject within groups [error (b)]	31.0	240	0.1		
C [Task]	110.6	3	36.9	4.0	221.9*
AC [Data*Task]	0.4	3	0.1	4.0	.877
C x subject within groups [error (c)]	29.9	180	0.2		
BC [Mode*Task]	19.0	12	1.6	4.0	11.105*
ABC [Data*Mode*Task]	3.4	12	0.3	4.0	1.985
BC x subjects within groups [error (bc)]	102.5	720	0.1		

When the analysis of variance test indicates the presence of factor effects, the next step is to analyze the nature of those effects. If there are significant interactions, as there are in this case, the analysis of factor effects must be based on treatment means defined by both factor levels. For example, in a two-factor test, if the factors I and J have significant interaction, then the analysis of factor effects must be based on treatment means μ_{ij} .

Because Table 15 shows that the three-way interaction (ABC) effect is insignificant, the following analysis of treatment means focuses on only the significant two-way interaction (AB and BC) effects. Typically, this analysis involves multiple pairwise comparisons of treatment means (15:730,739). This analysis uses the Tukey method as described in Chapter 3.

In this analysis the Tukey method of multiple comparisons is used to consider the set of all pairwise comparisons of factor level means when one of the interacting factor's level is fixed. Recall from Chapter 3 that the Tukey method for contrast of treatment means has the following form (Equation (6)):

$$\hat{L} \pm Ts\{\hat{L}\}$$

When a confidence interval for the contrast of means computed through Equation (6) includes zero, then the means are not significantly different. All of the comparisons use a family confidence coefficient of .95. "A family of pairwise comparisons is considered to be correct if every pairwise comparison in the family is correct" (15:582). Thus, when the family confidence coefficient is .95 all pairwise comparisons in the family will be correct in 95 percent of the families.

The first comparison of means (hypothesis 4) considers the effect of the mode of presentation when the task anchoring level is held constant (BC interaction). In analyzing these comparisons it is helpful to have both a visual and tabular representation of this data. Figure 11 illustrates the mode of presentation means with their confidence intervals while Table 16 contains all of the Tukey pairwise comparison for the HH (c_1) task anchoring level.

The left column of the Tukey contrast of means table (Tables 16 - 23, 25) identifies the mode of presentation means being compared. The L(hat) column displays the difference in the means being compared. The Ts{L{hat)} value is the distance from the mean to the upper (Column 4) and lower limits (Column 5) of the confidence interval.

Finally, an "X" is placed in the last column to show that the means being compared are significantly different.

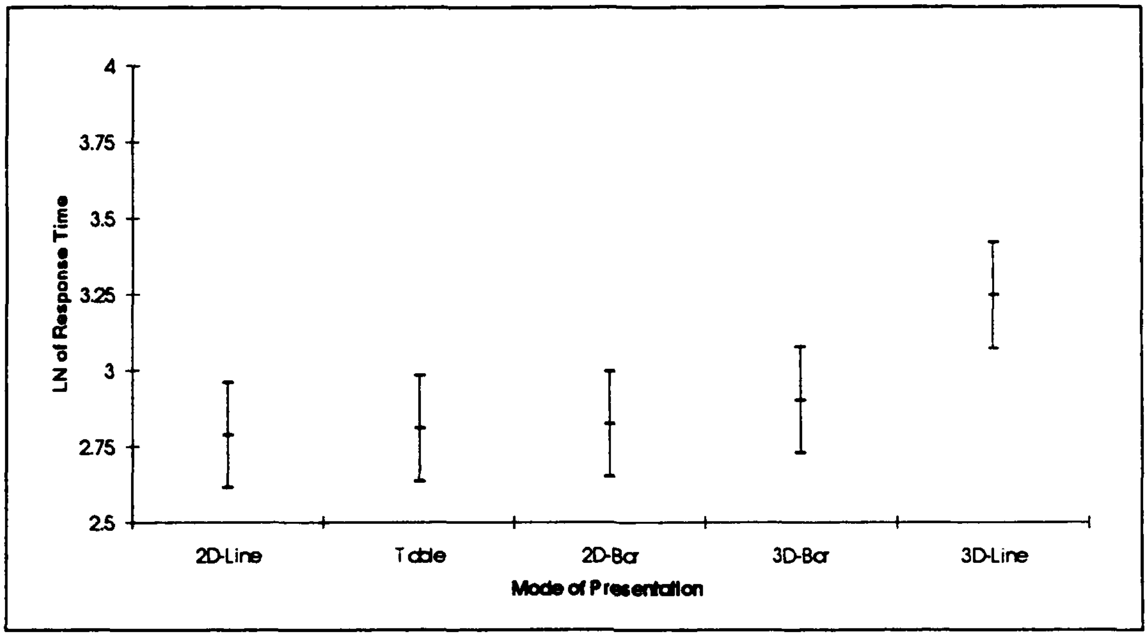


Figure 11. Mode of Presentation Mean and Confidence Intervals for Task Anchoring Level (c_1).

Table 16. Tukey Contrast of Means for Task Anchoring Level (c_1).

Comparison	L(hat)	Ts{L(hat)}	Upper Limit	Lower Limit	Reject
2D-Line vs Table	-0.02200	0.17394	0.15194	-0.19595	
2D-Line vs 2D-Bar	-0.03537	0.17394	0.13857	-0.20932	
2D-Line vs 3D-Bar	-0.11544	0.17394	0.05850	-0.28939	
2D-Line vs 3D-Line	-0.45985	0.17394	-0.28591	-0.63379	X
Table vs 2D-Bar	-0.01337	0.17394	0.16057	-0.18731	
Table vs 3D-Bar	-0.09344	0.17394	0.08050	-0.26738	
Table vs 3D-Line	-0.43785	0.17394	-0.26390	-0.61179	X
2D-Bar vs 3D-Bar	-0.08007	0.17394	0.09387	-0.25401	
2D-Bar vs 3D-Line	-0.42448	0.17394	-0.25053	-0.59842	X
3D-Bar vs 3D-Line	-0.34441	0.17394	-0.17046	-0.51835	X

From Figure 11, it appears that only the three-dimensional line mode of presentation mean is significantly different than the other four mode of presentation means. The Tukey

comparison in Table 16 validates that this perception is correct. The results of this analysis show that subjects interpreting tables, two-dimensional bar, two-dimensional line and three-dimensional bar graphs expend the same amount of time performing elementary data collection tasks with a HH Task Anchoring Level (c_1). On the other hand, it takes subjects longer to interpret three-dimensional line graphs for the same elementary data collection tasks (investigative question four).

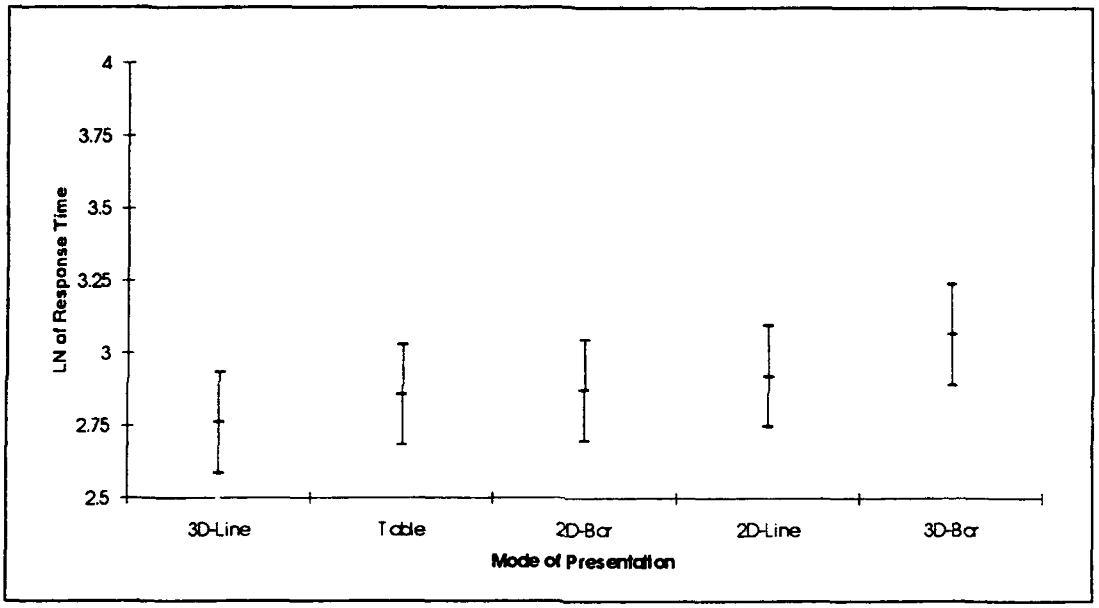


Figure 12. Mode of Presentation Mean and Confidence Intervals for Task Anchoring Level (c_2).

Table 17. Tukey Contrast of Means for Task Anchoring Level (c_2).

Comparison	L(hat)	Ts{L(hat)}	Upper Limit	Lower Limit	Reject
3D-Line vs Table	-0.09463	0.17394	0.07932	-0.26857	
3D-Line vs 2D-Bar	-0.11184	0.17394	0.06210	-0.28579	
3D-Line vs 2D-Line	-0.16150	0.17394	0.01244	-0.33544	
3D-Line vs 3D-Bar	-0.30465	0.17394	-0.13071	-0.47859	X
Table vs 2D-Bar	-0.01722	0.17394	0.15672	-0.19116	
Table vs 2D-Line	-0.06687	0.17394	0.10707	-0.24082	
Table vs 3D-Bar	-0.21002	0.17394	-0.03608	-0.38397	X
2D-Bar vs 2D-Line	-0.04965	0.17394	0.12429	-0.22360	
2D-Bar vs 3D-Bar	-0.19280	0.17394	-0.01886	-0.36675	X
2D-Line vs 3D-Bar	-0.14315	0.17394	0.03079	-0.31709	

Figure 12 and Table 17 contains all of the Tukey pairwise comparison for the HL (c_2) task anchoring level. From Figure 12, it appears that the three-dimensional bar mode of presentation mean is significantly different than the three-dimensional line, table, and two-dimensional bar mode of presentation means. The Tukey comparison in Table 17. validates that this perception is correct. The results of this analysis show that subjects interpreting three-dimensional line, table, and two-dimensional bar graphs expend the same amount of time performing elementary data collection tasks with a HL task anchoring level (c_2). The results also show that it takes subjects longer to interpret three-dimensional bar graphs for the same elementary data collection tasks. Finally, it is interesting to note that subjects performance with the two-dimensional line graphs cannot be differentiated from any of the other mode of presentations (investigative question four).

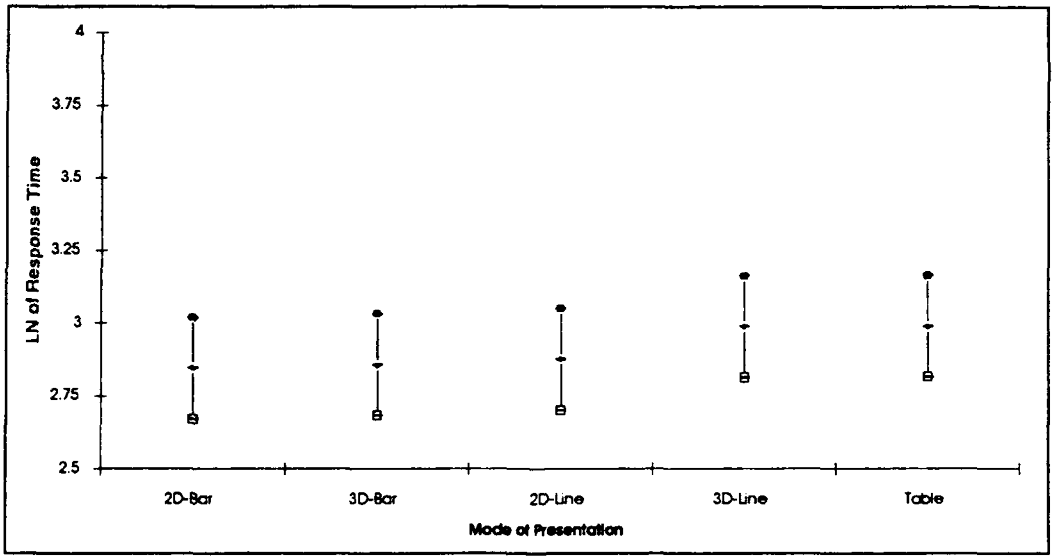


Figure 13. Mode of Presentation Mean and Confidence Intervals for Task Anchoring Level (c_3).

Figure 13 and Table 18 contains all of the Tukey pairwise comparison for the LH (c_3) task anchoring level. From Figure 13, it appears that none of the mode of presentation

means are significantly different. The Tukey comparison in Table 18 validates that this perception is correct.

Table 18. Tukey Contrast of Means for Task Anchoring Level (c_3).

Comparison	L(hat)	T s{L(hat)}	Upper Limit	Lower Limit	Reject
2D-Bar vs 3D-Bar	-0.01164	0.17394	0.16230	-0.18558	
2D-Bar vs 2D-Line	-0.03026	0.17394	0.14368	-0.20421	
2D-Bar vs 3D-Line	-0.14230	0.17394	0.03164	-0.31625	
2D-Bar vs Table	-0.14397	0.17394	0.02997	-0.31791	
3D-Bar vs 2D-Line	-0.01862	0.17394	0.15532	-0.19257	
3D-Bar vs 3D-Line	-0.13066	0.17394	0.04328	-0.30461	
3D-Bar vs Table	-0.13233	0.17394	0.04161	-0.30627	
2D-Line vs 3D-Line	-0.11204	0.17394	0.06190	-0.28598	
2D-Line vs Table	-0.11371	0.17394	0.06024	-0.28765	
3D-Line vs Table	-0.00167	0.17394	0.17228	-0.17561	

The results of this analysis show that subjects expend the same amount of time performing elementary data collection tasks with a LH task anchoring level (c_3) no matter which mode of presentation they are interpreting (investigative question four).

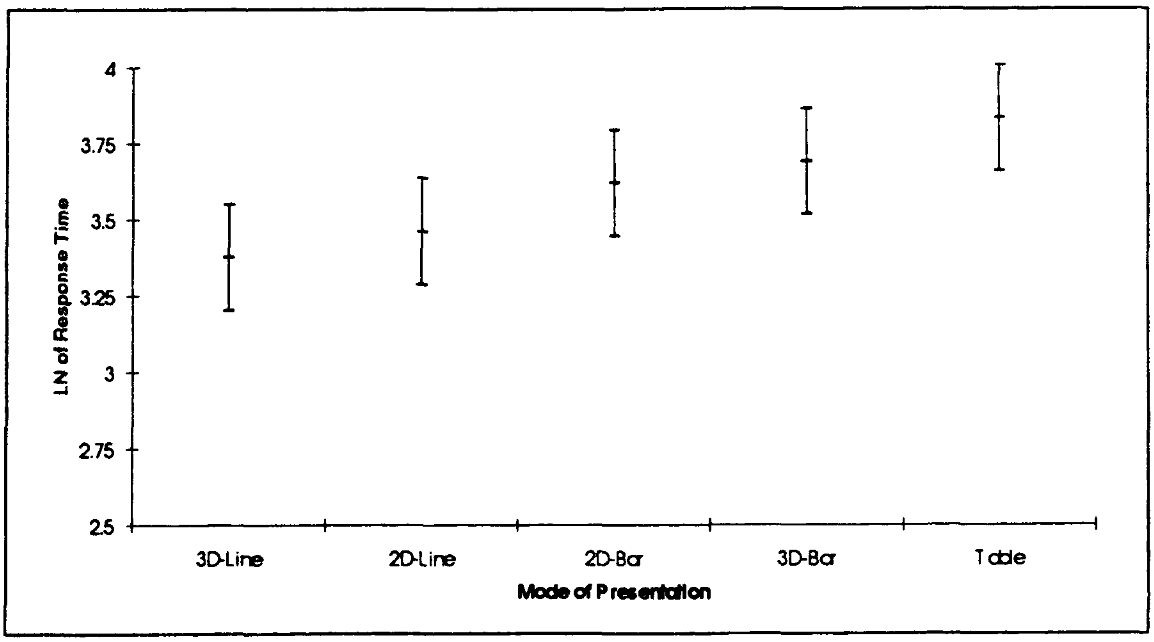


Figure 14. Mode of Presentation Mean and Confidence Intervals for Task Anchoring (c_4).

Figure 14 and Table 19 contains all of the Tukey pairwise comparison for the LL (c_4) task anchoring level. From Figure 14, it appears that there are four groups of means: (1) three-dimensional line and two-dimensional line; (2) two-dimensional line and two-dimensional bar; (3) two-dimensional bar and three-dimensional bar; and (4) three-dimensional bar and tables.

Table 19. Tukey Contrast of Means for Task Anchoring Level (c_4).

Comparison	L(hat)	T s{L(hat)}	Upper Limit	Lower Limit	Reject
3D-Line vs 2D-Line	-0.08636	0.17394	0.08758	-0.26030	
3D-Line vs 2D-Bar	-0.24458	0.17394	-0.07064	-0.41853	X
3D-Line vs 3D-Bar	-0.31431	0.17394	-0.14037	-0.48825	X
3D-Line vs Table	-0.45539	0.17394	-0.28145	-0.62933	X
2D-Line vs 2D-Bar	-0.15822	0.17394	0.01572	-0.33217	
2D-Line vs 3D-Bar	-0.22795	0.17394	-0.05400	-0.40189	X
2D-Line vs Table	-0.36903	0.17394	-0.19509	-0.54297	X
2D-Bar vs 3D-Bar	-0.06972	0.17394	0.10422	-0.24367	
2D-Bar vs Table	-0.21081	0.17394	-0.03686	-0.38475	X
3D-Bar vs Table	-0.14108	0.17394	0.03286	-0.31502	

Once again, the Tukey comparison in Table 19 validates that this perception is correct. The results of this analysis show that there is no distinct division between the groups. However, subjects interpreting the line graphs expend less time performing elementary data collection tasks with a LL task anchoring level (c_4), than they do interpreting the other modes of presentation. The results also show that it takes subjects the longest amount of time to interpret tables for the same elementary data collection tasks (investigative question four).

Finally, it is interesting to note through a comparison of Figures 11 - 14, that subjects (regardless of mode of presentation) performing elementary data collection tasks with LL task anchoring levels expend more time than with any other task anchoring level.

The second comparison of means (hypothesis 5) considers the effect of the data-set when the mode of presentation is held constant (AB interaction).

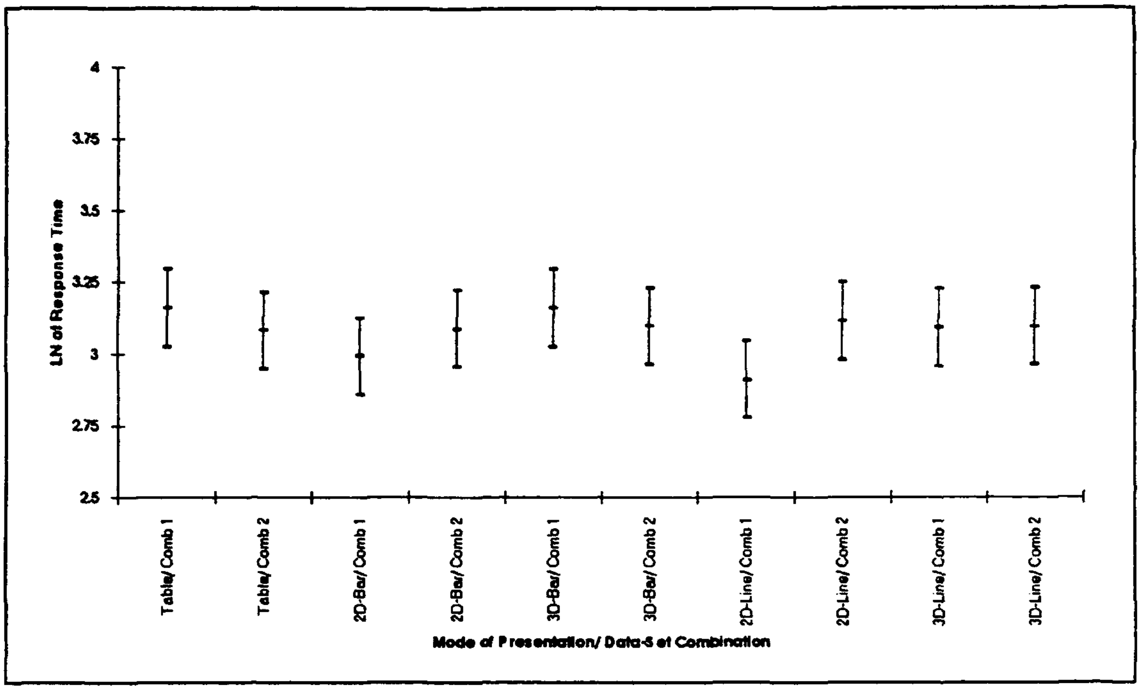


Figure 15. Mode of Presentation Mean and Confidence Intervals for Data-Set Combinations (A).

Table 20. Tukey Contrast of Means for Mode of Presentation and Data-Set Combinations.

Comparison	L(hat)	Ts{L(hat)}	Upper Limit	Lower Limit	Reject
Table/ Comb 1 vs Table/ Comb 2	0.07840	0.13388	0.21228	-0.05548	
2D-Bar/ Comb 1 vs 2D-Bar/ Comb 2	-0.09589	0.13388	0.03799	-0.22977	
3D-Bar/ Comb 1 vs 3D-Bar/ Comb 2	0.06314	0.13388	0.19702	-0.07074	
2D-Line/ Comb 1 vs 2D-Line/ Comb 2	-0.20394	0.13388	-0.07006	-0.33783	X
3D-Line/ Comb 1 vs 3D-Line/ Comb 2	-0.00449	0.13388	0.12939	-0.13837	

Figure 15 and Table 20 contains all of the Tukey pairwise comparisons for the analysis of the effects of the mode of presentation and data-set combinations. From Figure 15, it appears that there is only one mode of presentation, two-dimensional line graphs, where the interaction with the data-set combination produces a significant difference in the subjects response time. The Tukey comparison in Table 20 validates that this perception is correct. The results of this analysis suggest that data-sets used in this experiment did not have a significant effect. This was expected because the data-sets were

intentionally kept as similar as possible to minimize their influence. These results do not indicate that the data-set should be neglected when choosing a mode of presentation! Certainly, one can easily imagine situations where the data-set may preclude the use of a particular mode of presentation. One example of this, demonstrated early in this chapter, is where the three-dimensional graph obscures data.

Demographic Analysis

Tests 8 - 11 were conducted to compare mode of presentation and task anchoring treatment means versus demographic data to determine if a difference in mean response times could be attributed to demographic characteristics. The accuracy of the subjects response, considering subjects characteristics, was not included in this demographic analysis. Accuracy was not included because accuracy performance was high for the majority of subjects regardless of the mode of presentation or the task anchoring (refer to Table 14). The major performance variance among subjects were attributed to time differences required for extracting the relative responses from the graphical presentations. Therefore, subject response time will be the only dependent variable analyzed in this section.

The results of previous analysis suggested that the data-sets used in this experiment did not have a significant effect. Therefore, the data-set combination factor (A) was excluded from this analysis. This resulted in eliminating the two data-set combination groups, and combining them into one data group of 62 subjects. The data-set combination for factor A was replaced with four separate demographic characteristics. Separate analyses will determine the main effect and interactive effects of each of these demographic characteristics.

The subject's training level, rank, gender and education level were the four demographic characteristics determined to be important (end-of-exercise questions 10, 13,

12, and 14, respectively). These characteristics were chosen because the researchers believed these characteristics (factor A) would have the greatest impact on the subjects response time. These characteristics are classified into the following treatment levels:

(1) The training level of the subjects was divided into three separate treatment levels: formal training (21 subjects), informal training (17 subjects), and no training (24 subjects). The formal and informal training classifications included those subjects who had training on either graph construction or interpretation.

(2) The rank of the subjects was divided into two treatment levels: low (48 subjects) and high (14 subjects). The low rank category consists of individuals with rank between GS-3 to GS-12 or O-1 to O-3. The high rank category includes individuals with rank between GS/M-13 to GS/M-15 or O-4 and above.

(3) There were only two treatment levels for gender: 48 male subjects and 14 female subjects.

(4) The subject's education level was divided into two treatment levels: low (27 subjects) and high (35 subjects). High school graduates through Baccalaureate Degree recipients were categorized in the low level. Subjects who had received some graduate courses to those subjects who were Doctoral Degree recipients were classified in the high level.

There were four tests conducted in the demographic analysis. All the tests tested for treatment mean differences, for all four factors, as they relate to subject response time. Tests 8 was conducted to test for the main effects associated with the A factors; training level (8a), rank (8b), gender (8c), and education level (8d). Test 9 tests for mode of presentation (B) and training level (9a), rank (9b), gender (9c), and education level (9d) (A), two-way factor interaction. Test 10 tests for task anchoring level (C) and training level (10a), rank (10b), gender (10c), and education level (10d) (A), two-way factor interaction. Finally, test 11 tests for mode of presentation (B), task anchoring (C), and

training level (11a), rank (11b), gender (11c), and education level (11d) (A), three-way factor interaction. Tests 8 - 11 and their associated hypotheses are described as follows:

Test 8: Test for main effects associated with the factors; training level, rank, gender and education level. The experimental hypotheses for Test 8 were:

(8a) H_o: No difference exists between the training level treatment means as they relate to subject response time.

H_a: At least two training level treatment means differ.

(8b) H_o: No difference exists between the rank treatment means as they relate to subject response time.

H_a: The two rank treatment means differ.

(8c) H_o: No difference exists between the gender treatment means as they relate to subject response time.

H_a: The two gender treatment means differ.

(8d) H_o: No difference exists between the education level treatment means as they relate to subject response time.

H_a: At least two education level treatment means differ.

Test 9: Test for mode of presentation and training, rank, gender and education level factor interaction. The experimental hypotheses for Test 9 were:

(9a) H_o: The factors mode of presentation and training level do not interact to affect response time means.

H_a: At least two treatment means differ.

(9b) H_o: The factors mode of presentation and rank do not interact to affect response time means.

H_a: At least two treatment means differ.

(9c) H_0: The factors mode of presentation and gender do not interact to affect response time means.

H_a: At least two treatment means differ.

(9d) H_0: The factors mode of presentation and education level do not interact to affect response time means.

H_a: At least two treatment means differ.

Test 10: Test for task anchoring level and training, rank, gender and education level factor interaction. The experimental hypotheses for Test 10 were:

(10a) H_0: The factors task anchoring level and training level do not interact to affect response time means.

H_a: At least two treatment means differ.

(10b) H_0: The factors task anchoring level and rank do not interact to affect response time means.

H_a: At least two treatment means differ.

(10c) H_0: The factors task anchoring level and gender do not interact to affect response time means.

H_a: At least two treatment means differ.

(10d) H_0: The factors task anchoring level and education level do not interact to affect response time means.

H_a: At least two treatment means differ.

Test 11: Test for mode of presentation, task anchoring, and training, rank, gender and education level factor interaction. The experimental hypotheses for Test 11 were:

(11a) H_0: The factors mode of presentation, task anchoring, and training level do not interact to affect response time means.

H_a: At least two treatment means differ.

(11b) H_o: The factors mode of presentation, task anchoring, and rank do not interact to affect response time means.

H_a: At least two treatment means differ.

(11a) H_o: The factors mode of presentation, task anchoring, and gender do not interact to affect response time means.

H_a: At least two treatment means differ.

(11a) H_o: The factors mode of presentation, task anchoring, and education level do not interact to affect response time means.

H_a: At least two treatment means differ.

Tables 21, 22, 23, and 25 show the results of the multifactor ANOVA with repeated measures on the response time for the demographic factors; training level, rank, gender, and education level (Appendix G contains the calculations that support Tables 21, 22, 23, and 25). All the ANOVA table calculations were accomplished in accordance with the computational procedures described in the statistical analysis section of Chapter 3, significant F ratios are emphasized with asterisks. Because the mode of presentation (B) and task anchoring level (C) factors have been analyzed in the previous section, the following discussion of the summary of analysis tables will address only the main and interactive effects of the factors (A); training, rank, gender, and education level, with the B and C factors.

As expected, ANOVA Table 21 shows that the main effects of factors B and C, and the BC interaction effect are significant; however, the main effect of factors A, training level, is not significant, therefore, the hypothesis 8a is not rejected. Also, hypotheses 9a, 10a, and 11a are not rejected because the main effect of factor A and the interaction effects of AB, AC, and ABC are insignificant. Therefore, the results of the analysis show that the training level of the subjects (formal, informal, no training) does not have an effect on the response time (investigative question five).

Table 21. Summary of Analysis of Variance for Training.

Source of Variation	SS	df	MS	Fcrit	F
Between Subjects	56.2	61			
A [Training Level]	1.4	2	0.697	4.0	0.750
Subject within groups [error (a)]	54.8	59	0.929		
Within subjects	302.9	1178			
B [Mode]	2.6	4	0.649	4.0	4.547*
AB [Training*Mode]	0.7	8	0.089	4.0	0.625
B x subject within groups [error (b)]	33.7	236	0.143		
C [Task]	110.6	3	36.881	4.0	225.2*
AC [Training*Task]	1.4	6	0.227	4.0	1.387
C x subject within groups [error (c)]	29.0	177	0.164		
BC [Mode*Task]	19.0	12	1.582	4.0	10.915*
ABC [Training*Mode*Task]	3.4	24	0.140	4.0	0.964
BC x subjects within groups [error (bc)]	102.6	708	0.145		

Once again, Table 22 shows that the main effects of factors B and C, and the BC interaction effect are significant; however, the main effect of factors A, rank, is not significant, therefore, the hypothesis 8b is not rejected. Also, hypotheses 9b, 10b, and 11b are not rejected because the main effect of factor A and the interaction effects of AB, AC, and ABC are insignificant. Therefore, the results of the analysis also show that the rank of the subjects (low or high rank) does not have an effect on the response time (investigative question five).

Table 22. Summary of Analysis of Variance for Rank.

Source of Variation	SS	df	MS	Fcrit	F
Between Subjects	56.2	61			
A [Rank]	0.1	1	0.091	4.0	0.097
Subject within groups [error (a)]	56.1	60	0.936		
Within subjects	302.9	1178			
B [Mode]	2.6	4	0.649	4.0	4.547*
AB [Rank*Mode]	0.1	4	0.036	4.0	0.252
B x subject within groups [error (b)]	34.3	240	0.143		
C [Task]	110.6	3	36.881	4.0	220.0*
AC [Rank*Task]	0.2	3	0.056	4.0	0.335
C x subject within groups [error (c)]	30.2	180	0.168		
BC [Mode*Task]	19.0	12	1.582	4.0	10.865*
ABC [Rank*Mode*Task]	1.1	12	0.095	4.0	0.650
BC x subjects within groups [error (bc)]	104.8	720	0.146		

Table 23 also shows that the main effects of factors B and C, and the BC interaction effect are significant. The analysis also shows that the main effect of factor A, gender, and the AB and ABC interactive effects are not significant; however, the AC interaction effect is significant. Therefore, this results in rejecting only hypothesis 10c, and not rejecting hypotheses 8c, 9c, and 11c.

When the analysis of variance test indicates the presence of factor effects, the next step is to analyze the nature of those effects. If there are significant interactions, as there are in this case, the analysis of factor effects must be based on treatment means defined by

both factor levels. Because Table 23 shows that the three-way interaction (ABC) effect is insignificant, the following analysis of treatment means focuses on only the significant

Table 23. Summary of Analysis of Variance for Gender.

Source of Variation	SS	df	MS	Fcrit	F
Between Subjects	56.2	61			
A [Gender]	0.3	1	0.284	4.0	0.304
Subject within groups [error (a)]	55.9	60	0.932		
Within subjects	302.9	1178			
B [Mode]	2.6	4	0.649	4.0	4.676*
AB [Gender*Mode]	1.1	4	0.273	4.0	1.962
B x subject within groups [error (b)]	33.3	240	0.139		
C [Task]	110.6	3	36.881	4.0	235.0*
AC [Gender*Task]	2.1	3	0.698	4.0	4.446*
C x subject within groups [error (c)]	28.3	180	0.157		
BC [Mode*Task]	19.0	12	1.582	4.0	10.860*
ABC [Gender*Mode*Task]	1.1	12	0.090	4.0	0.619
BC x subjects within groups [error (bc)]	104.9	720	0.146		

two-way interaction (AC) effect. Typically, this analysis involves multiple pairwise comparisons of treatment means (15:730,739). This analysis uses the same Tukey method as described earlier.

All of the comparisons use a family confidence coefficient of .95. The first comparison of means (hypothesis 10c) considers the effect of gender when the task

anchoring level is held constant (AC interaction). Figure 16 illustrates the gender means with their confidence intervals while Table 24 contains all of the Tukey pairwise comparisons for the task anchoring levels.

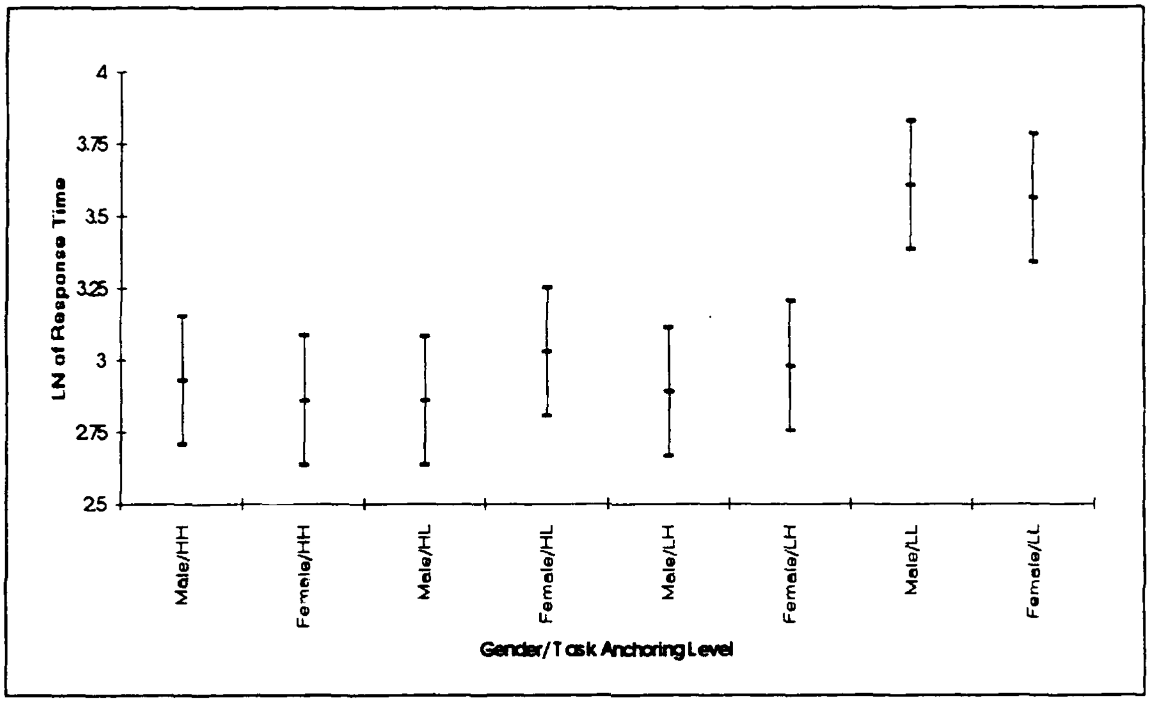


Figure 16. Task Anchoring Level Mean and Confidence Intervals for Gender (A).

Table 24. Tukey Contrast of Means for Gender and Task Anchoring Level.

Comparison	L(hat)	Ts{L(hat)}	Upper Limit	Lower Limit	Reject
Male / HH vs Female / HH	0.06877	0.22287	0.29164	-0.15410	
Male / HL vs Female / HL	-0.17057	0.22287	0.05230	-0.39344	
Male / LH vs Female / LH	-0.08901	0.22287	0.13386	-0.31189	
Male / LL vs Female / LL	0.04610	0.22287	0.26897	-0.17678	

Figure 16 and Table 24 contains all of the Tukey pairwise comparison for the analysis of the effects of gender and task anchoring level. From Figure 16, it appears that the gender of the subjects has no interaction effect with any of the four task anchoring levels. The Tukey comparison in Table 24 verifies that this perception is correct. The results of

this analysis suggest that regardless of gender, subjects spend the same amount of time performing elementary data collection tasks (investigative question five). Therefore, hypothesis 10c is not rejected.

Table 25. Summary of Analysis of Variance for Education Level.

Source of Variation	SS	df	MS	Fcrit	F
Between Subjects	56.2	61			
A [Education Level]	3.6	1	3.550	4.0	4.043*
Subject within groups [error (a)]	52.7	60	0.878		
Within subjects	302.9	1178			
B [Mode]	2.6	4	0.649	4.0	4.700*
AB [Education*Mode]	1.3	4	0.315	4.0	2.281
B x subject within groups [error (b)]	33.2	240	0.138		
C [Task]	110.6	3	36.881	4.0	230.3*
AC [Education*Task]	2.1	3	0.508	4.0	3.174
C x subject within groups [error (c)]	28.8	180	0.160		
BC [Mode*Task]	19.0	12	1.582	4.0	10.992*
ABC [Education*Mode*Task]	1.7	12	0.140	4.0	0.965
BC x subjects within groups [error (bc)]	104.3	720	0.145		

Table 25 shows that the main effects of factors A, B, C, and the BC interaction effect are significant. Once again, the main effects of factors B and C and the BC interaction effect are expected to be significant. It is interesting to note that although the main effect of factor A is significant, the analysis shows that the AB, AC, and ABC interactive effects

are not significant. However, remember that the conservative F tests from Table 8 (Chapter 3) were used to determine the significance of factor effects. If the conservative F tests were not used, then perhaps the AB and AC interactive effects would be significant since the F ratio values for these interactive effects are relatively high. Although, this analysis results in not rejecting hypotheses 9d, 10d, and 11d, and rejecting hypothesis 8d, the following discussion will also include the analysis of the AB (9d) and AC (10d) interactive effects.

The first comparison of means (hypothesis 10d) considers the effect of education level when the task anchoring level is held constant (AC interaction). Figure 17 illustrates the gender means with their confidence intervals while Table 26 contains all of the Tukey pairwise compaiisons for the task anchoring levels.

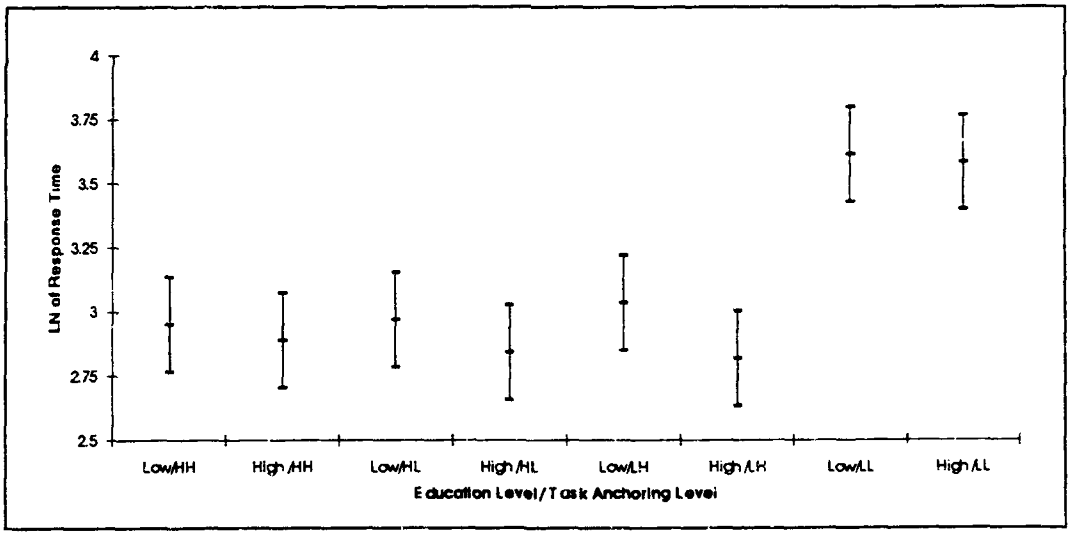


Figure 17. Task Anchoring Level Mean and Confidence Intervals for Education Level(A).

Table 26. Tukey Contrast of Means for Education Level and Task Anchoring Level.

Comparison	L(hat)	Ts{L(hat)}	Upper Limit	Lower Limit	Reject
Low/HH vs High/HH	0.06226	0.18490	0.24717	-0.12264	
Low/HL vs High/HL	0.12449	0.18490	0.30940	-0.06041	
Low/LH vs High/LH	0.21526	0.18490	0.40017	0.03036	X
Low/LL vs High/LL	0.02966	0.18490	0.21457	-0.15524	

Figure 17 and Table 26 contains all of the Tukey pairwise comparisons for the analysis of the effects of the education level and task anchoring level. From Figure 17, it appears that there is only one task anchoring level, LH (c3), where the interaction with the education level produces a significant difference in the subjects response time. The Tukey comparison in Table 26 verifies that this perception is correct. In the ANOVA table, the results suggest that the AC interactive effect was insignificant; however, the comparison of means analysis show that there is an interactive effect with one of the four task anchoring levels (c3); therefore, hypothesis 10d is rejected (investigation question five).

The second comparison of means (hypothesis 10d) considers the effect of education level when the mode of presentation is held constant (AB interaction). Figure 18 illustrates the educational level means with their confidence intervals while Table 27 contains all of the Tukey pairwise comparisons for the mode of presentations.

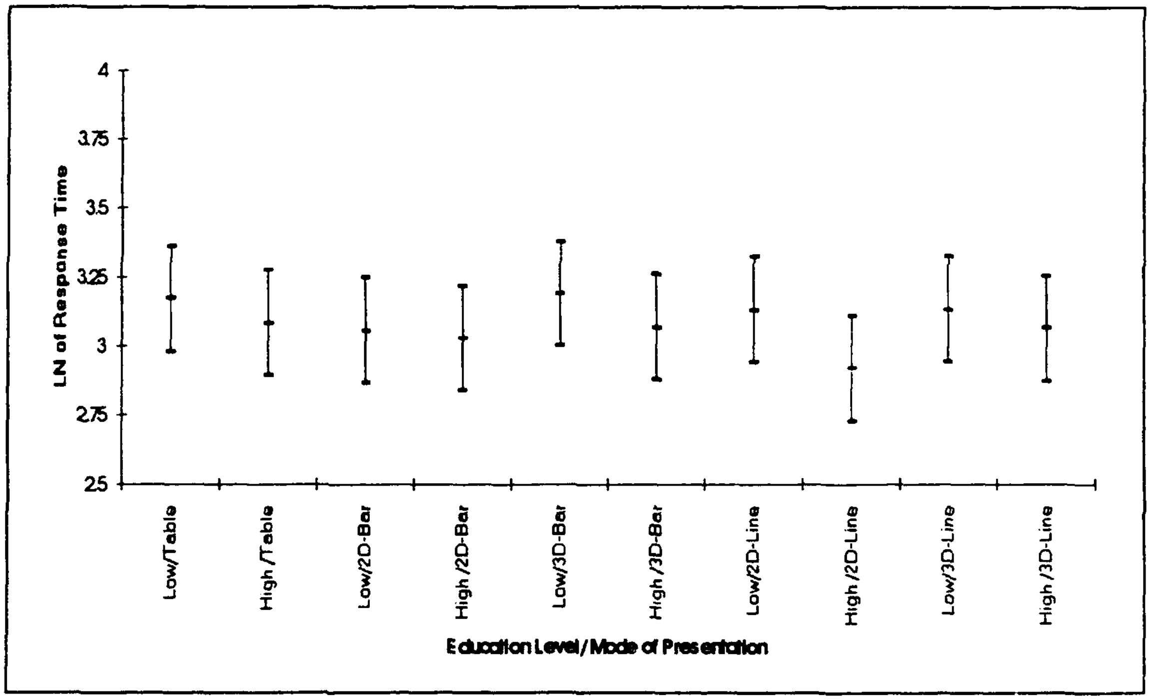


Figure 18. Mode of Presentation Mean and Confidence Intervals for Education Level (A).

From Figure 18, it appears that there is only one mode of presentation, two-dimensional line, where the interaction with the education level produces a significant difference in the subjects response time. The Tukey comparison in Table 27 verifies that this perception is correct. In the ANOVA table, the results suggest that the AB interactive effect was also insignificant; however, the comparison of means analysis show that there is

Table 27. Tukey Contrast of Means for Education Level and Mode of Presentation.

Comparison	L(hat)	Ts{L(hat)}	Upper Limit	Lower Limit	Reject
Low/ Table vs High / Table	0.08712	0.18983	0.27695	-0.10271	
Low/ 2D-Bar vs High / 2D-Bar	0.02885	0.18983	0.21868	-0.16098	
Low/ 3D-Bar vs High / 3D-Bar	0.12287	0.18983	0.31270	-0.06696	
Low/ 2D-Line vs High / 2D-Line	0.21368	0.18983	0.40351	0.02385	X
Low/ 3D-Line vs High / 3D-Line	0.06761	0.18983	0.25744	-0.12222	

an interactive effect with one of the five modes of presentation; therefore, hypothesis 9d is also rejected (investigative question five).

Summary

Chi-square analysis was used to determine if differences exist between the mode of presentation and task anchoring level treatment means as they relate to response accuracy. This analysis was used to answer investigative question three. The results of the Chi-square analysis indicate that the majority of the subjects achieved a high level of accuracy performance across the different modes of presentation and task anchoring levels. In general, accuracy performance was high for most subjects regardless of the mode of presentation or the task anchoring, thus eliminating time-accuracy tradeoffs as a potential decision criterion for graphical format . Therefore, the major performance variance among subjects were attributed to time differences required for extracting the relative responses from the graphical presentations. Thus, the various modes of graphical

presentation do not affect the accuracy associated with given elementary data extraction tasks.

The general format of the Multifactor Analysis of Variance with Repeated Measures technique was used to identify differences between the various experimental treatment means. This method was used to determine the main and interaction effects of the mode, task, and data factors on the response time when the subject is observed under more than one treatment condition. When the analysis of variance returned a significant finding, the next step in the statistical analysis was to perform a comparison of means. The Tukey method was used for all pairwise comparisons of factor level means. All of the comparisons were analyzed with a family confidence coefficient of .95. The Multifactor Analysis of Variance with Repeated Measures and the Tukey comparison of means procedures were used to answer the fourth investigative question. The following paragraphs summarize the results of the analysis and explain the efficiency of the various modes of presentation associated with given elementary data extraction tasks.

(1) Subjects interpreting tables, two-dimensional bar, two-dimensional line and three-dimensional bar graphs expend the same amount of time performing elementary data collection tasks with a HH Task Anchoring Level (c_1).

(2) Subjects interpreting three-dimensional line, table, and two-dimensional bar graphs expend the same amount of time performing elementary data collection tasks with a HL task anchoring level (c_2). Subjects also took longer to interpret three-dimensional bar graphs for the same elementary data collection tasks. Finally, subjects performance with the two-dimensional line graphs could not be differentiated from any of the other modes of presentation.

(3) Subjects expend the same amount of time performing elementary data collection tasks with a LH task anchoring level (c_3) no matter which mode of presentation they are interpreting.

(4) There was no distinct division between the groups performing elementary data collection tasks with a LL task anchoring level (c_4). However, subjects interpreting the line graphs expend less time performing these elementary data collection tasks, than they did interpreting the other modes of presentation. It also takes subjects the longest to interpret tables for the same elementary data collection tasks.

(5) Finally, subjects (regardless of mode of presentation) performing elementary data collection tasks with LL task anchoring levels expend more time than with any other task anchoring level.

It appeared that there was only one mode of presentation, two-dimensional line graphs, where the interaction with the data-set combination produced a significant difference in the subjects response time. The results of the analysis indicated that data-sets used in this experiment did not have a significant effect. However, these results do not indicate that the data-set should be neglected when choosing a mode of presentation.

Tests were conducted to compare mode of presentation and task anchoring treatment means versus demographic data to determine if a difference in mean response times could be attributed to demographic characteristics. Four demographic characteristics were chosen for the analysis; training level, rank, gender, and education level. This analysis was used to answer investigative question five, and determine if there are any demographic characteristics of the participants which affect their ability to efficiently perform elementary data collection tasks. The following paragraphs summarize the results of the analysis.

(1) The training level of the subjects did not have an effect on the response time.

(2) The rank of the subjects does not have an effect on the response time.

(3) Regardless of gender, subjects spent the same amount of time performing elementary data collection tasks.

(4) It appeared that there was only one task anchoring level, LH (c_3) and one mode of presentation, two-dimensional line, where the interaction with the education level produced a significant difference in the subjects response time.

Chapter V, Conclusion, will summarize the results of the study, address investigative questions six, seven, and eight, and discuss the limitations of the study as well as the implications of the findings.

V. Conclusion

Introduction

A graphical image has the ability to summarize complex relationships among large quantities of data into an easily understood trend. This makes a graph an effective tool for influencing our perception of the relationships that exist in the data being portrayed. It also makes a graph extremely useful in the decision-making process. Using graphics is an effective method to communicate ideas, and it enhances the chance of success. Graphics are used to make a point, illustrate a trend, or make comparisons so the data are more easily understood. The presenter must select an appropriate graphical format that will capture the audience's attention and enable the audience to make an accurate decision.

In the past, researchers have focused a significant amount of attention on the effects of graphical format on decision-making. However, the question of whether or not graphs are better than tables for data presentation still remains. Much of the early research that compared graphs to tables provided conflicting results. DeSanctis (9), Davis (8), Tan and Benbasat (22), and Jarvenpaa and Dickson (13), provide numerous examples of studies that conflict. Some of the studies indicated graphs were superior, while others indicated they were not superior. There are still other studies where the findings are equivocal.

In an attempt to reduce these conflicting results, DeSanctis (9) wrote a paper that is instrumental for much of today's research because it identifies the major dependent variables in graphics research and provides the rationale for their use. Collectively, these variables are the basis for measuring the effectiveness of a data presentation format in experimental research. In our experiment we considered the following dependent variables: interpretation accuracy, decision speed and task performance.

Tan and Benbasat state that "the major cause of contradictory results is the various and differing tasks used in these experiments and the match (or mismatch) between the

task (i.e. the decision to be made based on the graph) and presentation method (i.e. the graph format)" (22:168). Jarvenpaa, Dickson, and DeSanctis state that "future research efforts will keep producing contradictory results unless researchers develop some type of taxonomy of task and start interpreting the results within the taxonomy" (13:144).

As a foundation for graphics research, Tan and Benbasat developed a task taxonomy and an information presentation taxonomy which were integrated to predict the best matches between task types and presentation types (22:168). This taxonomy is based on operational definitions of x-value anchoring, y-value anchoring, and entity (data-set) anchoring. *In other words, anchoring is the technique decision-makers use to break down and interpret graphs.*

To expound upon previous research accomplished by Davis (8), and Tan and Benbasat (22), this study incorporated elements of their research into the experiment. The objective of this study was to determine whether or not, and by how much, three-dimensional graphs are more efficient and accurate than two-dimensional graphs and tables, when presenting alternatives to decision makers. In this experiment, task complexity was measured using the method advocated by Davis. He proposed that the task characteristic is an important variable which needs to be controlled when determining the appropriateness of the graphical format, and one of the most important task characteristics to control is task complexity (8). This experiment also integrated the task and presentation taxonomies developed by Tan and Benbasat, and focused on elementary data extraction for tasks. Although this study has incorporated elements of their research into the experiment, another dimension has been added - three dimensional graphs. Previously, researchers have neglected to examine the effects of three-dimensional graphs on decision makers. Therefore, we have included three-dimensional graphs as an additional type of mode of presentation we will consider in the research.

This study compared and contrasted tables, two-dimensional line and bar charts, and three-dimensional line and bar charts to determine whether or not, and by how much, three-dimensional graphs are more efficient and accurate than two-dimensional graphs and tables.

Summary of Results

The following propositions developed by Tan and Benbasat (22) were used to guide the design of the experiment, interpret the findings, and answer investigative questions six, seven, and eight:

> **Proposition 1**: The performance of tasks (accuracy and speed) characterized by high x-value and high y-value (HH) anchoring is expected to be better facilitated by using vertical bar charts and tables than by using line graphs.
>
> **Proposition 2**: The performance of tasks (accuracy and speed) characterized by high x-value and low y-value (HL) anchoring is expected to be better facilitated by using vertical bar charts than by using tables and line graphs.
>
> **Proposition 3**: The performance of tasks (accuracy and speed) characterized by low x-value and high y-value (LH) anchoring is expected to be better facilitated by using line graphs than by using tables and bar charts.
>
> **Proposition 4**: The performance of tasks (accuracy and speed) characterized by both low x-value and y-value (LL) anchoring is expected to be better facilitated by using line graphs than by using bar charts and tables.

To address investigative question six, the researchers needs to determine if there are any elementary data collection tasks in which three-dimensional graphs facilitate more accurate solutions than two-dimensional graphs and tables. The results of the accuracy analysis indicate that the majority of the subjects achieved a high level of accuracy

performance across the different modes of presentation and task anchoring levels. However, the three-dimensional line graph had particularly low accuracy scores for HH and LL task anchoring. The reason for the low scores are attributed to the fact that the three-dimensional line graphs have a tendency to obscure data. In general, accuracy performance was high for most subjects regardless of the mode of presentation or the task anchoring. Therefore, the various modes of graphical presentation do not affect the accuracy associated with given elementary data extraction tasks. Thus, there are no elementary data collection tasks where three-dimensional graphs facilitate more accurate solutions than two-dimensional graphs and tables.

Investigative question seven is answered by determining if there are any elementary data collection tasks in which three-dimensional graphs facilitate more efficient solutions than two-dimensional graphs and tables. The following numbered paragraphs discuss the analysis of the results, on decision speed or time performance, which relate to question seven. These paragraphs directly correlate with the Tan and Benbasat numbered propositions stated earlier.

(1) In the analysis of the results on decision speed, the researchers discovered that the HH anchoring questions were not interpreted any differently for tables, two-dimensional bar, two-dimensional line and three-dimensional bar graphs. However, it took subjects longer to interpret three-dimensional line graphs for the HH elementary data collection task. This finding supports Tan and Benbasat's first proposition, except that two-dimensional line graphs were found to be equivalent in time performance as opposed to being longer.

(2) In contrast to Tan and Benbasat's proposition, it was determined through analysis that the two-dimensional bar charts, three-dimensional line graphs and tables were interpreted relatively the same while three-dimensional bar charts were interpreted longer for the HL anchoring questions. Subjects performance with the two-dimensional line

graphs could not be differentiated from any of the other mode of presentations. There was no clear distinction the bar charts were interpreted faster for the HL anchoring questions.

(3) Subjects spent the same amount of time performing elementary data collection tasks for the LH anchoring questions no matter which mode of presentations the subjects were interpreting. Tan and Benbasat had proposed that the line graphs would perform better. However, that distinction could not be made.

(4) There was no distinct division between the groups performing elementary data collection tasks for LL anchoring questions. However, subjects interpreting the line graphs spent less time performing these tasks, than they did interpreting the other modes of presentation. This finding supports Tan and Benbasat's fourth proposition. It was also noted that subjects (regardless of mode of presentation) performing LL elementary data collection tasks spent more time than with any other task anchoring question.

The very last question that needs to be answered (investigative question eight) is which graphical format is appropriate for a given task? Tan and Benbasat has determined through previous research which graphical format is most appropriate for a given task, and this research resulted in their four propositions. However, the results of this study were somewhat different than Tan and Benbasat's propositions.

For the HH anchoring questions, the results did not show that tables and bar charts were interpreted faster. As a matter of fact, the only distinction was that three-dimensional line graphs took the longest to interpret. Therefore, according to these results, three-dimensional line graphs are not recommended when using HH anchoring questions.

There were mixed results for the HL anchoring questions. Tan and Benbasat expect the bar charts to be interpreted faster; however, the three-dimensional bar chart took the longest to interpret. Thus, three-dimensional bar charts would not be recommended (according to these results) for HL anchoring questions.

All of the modes of presentations were interpreted relatively the same for the LH anchoring questions. Tan and Benbasat expected the line graphs to be the fastest; however, the results of this study showed no difference. Therefore, any of the modes of presentations could be used for the LH anchoring questions.

Subjects interpreting the line graphs spent less time performing LL anchoring questions, than they did interpreting the other modes of presentation. This was the only result which verifies Tan and Benbasat's proposition. Therefore, both two-dimensional and three-dimensional line graphs are recommended when using LL anchoring questions.

Limitations of the Study

This study is limited in several ways. First, the results of the study are only applicable to five graphical formats investigated in our research. Future researchers may want to build on this study and consider additional modes of presentation, such as horizontal bar charts, pie charts, dot charts, Tukey box plots, and symbol charts. Second, the task complexity was relatively simple. This resulted in high levels of observed accuracy. Future researchers could examine whether or not the task anchoring propositions hold true given greater task complexity. Finally, although color was incorporated into the experiment, it was held constant and was not considered an independent variable. In the future, the effect of changing color on both accuracy and speed could be considered.

Implications of the Findings

Although this study is limited in several ways, the results still suggest that Tan and Benbasat's task anchoring concept is an important aspect in understanding human processing of graphical information. This study supports their conclusion that knowledge of the matching relationship between task anchoring characteristics and mode of presentation can provide a basis for choosing between graphical formats. The implications

of this study are simple: Graph designers and decision-makers must be trained to identify which graph is appropriate for a given task. Proper training will not only result in more accurate and effective decisions, it will also make graphs a more useful form of communicating vast amounts of information.

The DoD is an organization where essential decisions must be made by managers at all levels of government. Communication and the transfer of necessary information is critical to our national defense. The data presented to managers is often in the form of graphics to help facilitate decision making and consolidate enormous quantities of data. The results attained from graphics research will legitimately aid decision makers in understanding data formulation. The research will help managers understand issues such as graph characteristics, which modes of presentation are most suitable for a given task question, which modes of presentation have the lowest comprehension, and which modes of presentation are the most time consuming. If DoD managers are educated on the effect of ill-prepared graphics, and how these graphs can misrepresent data, they will be given the tools to become even better decision makers.

In conclusion, there is still much work to be done in evaluating the effect of graphical format on human interpretation. As studies continue to build on the understandings of graph interpretation, more effective and more useful graphical formats will be created.

Appendix A. Experimental Item

This appendix contains a copy of the slides that were displayed on the computer screen during the experiment. Although these slides are black and white, the actual slides were displayed in color during the experiment. Pages 98-123 contain the slides that were shown to Group 1 (G1), while Pages 124-149 contain the slides that were shown to Group 2 (G2).

With the exception of the introduction slides (Page 98 and 124), the slides were presented in a random order. To facilitate an easy review of the experimental item, the slides have been grouped by mode of presentation. Within each group the charts are order by task (HH, HL, LH, and LL). The last five charts of each group (Pages 119-123 and 145-149) are the masking charts. The masking charts were used to hide the intent of the experiment and no data was collected for them.

Financial information is provided for four regional offices: North, South, East and West. As the Vice-President for Armagedon Corporation, you have asked for financial information from the last seven periods for each of the four regional offices. Your job is to assess and compare the financial information for each of these regions to determine if there are any problems. Information will be presented in 25 charts (graphs and tables).

Each of the four regions has an equitable sales base and has approximately the same number of customers. In other words they are on a "level playing field."

Please select the most appropriate answer from the choices provided and type the number (only once) associated with the chosen answer. The computer will automatically go to the next screen. Please be aware there may be a slight delay.

The total time for the exercise should not exceed approximately 15 minutes. Please press any key to continue!

Annual Sales ($ Thousands)

Region	North	South	East	West
Year				
1987	596	596	679	905
1988	399	432	749	692
1989	531	379	632	700
1990	442	343	556	648
1991	507	398	620	540
1992	691	556	730	489
1993	589	353	858	759

In 1989, which region's sales were closest to $600?
(1) North (2) South (3) East (4) West

Monthly Profits ($ Thousands)

Region / Month	North	South	East	West
Jan	71	296	379	605
Feb	99	132	449	392
Mar	231	79	332	400
Apr	142	43	256	348
May	207	98	320	240
Jun	391	256	430	189
Jul	289	53	558	459

Which region's profits increased each month between Jan and Mar?
(1) North (2) South (3) East (4) West

Yearly Expenses ($ Thousands)

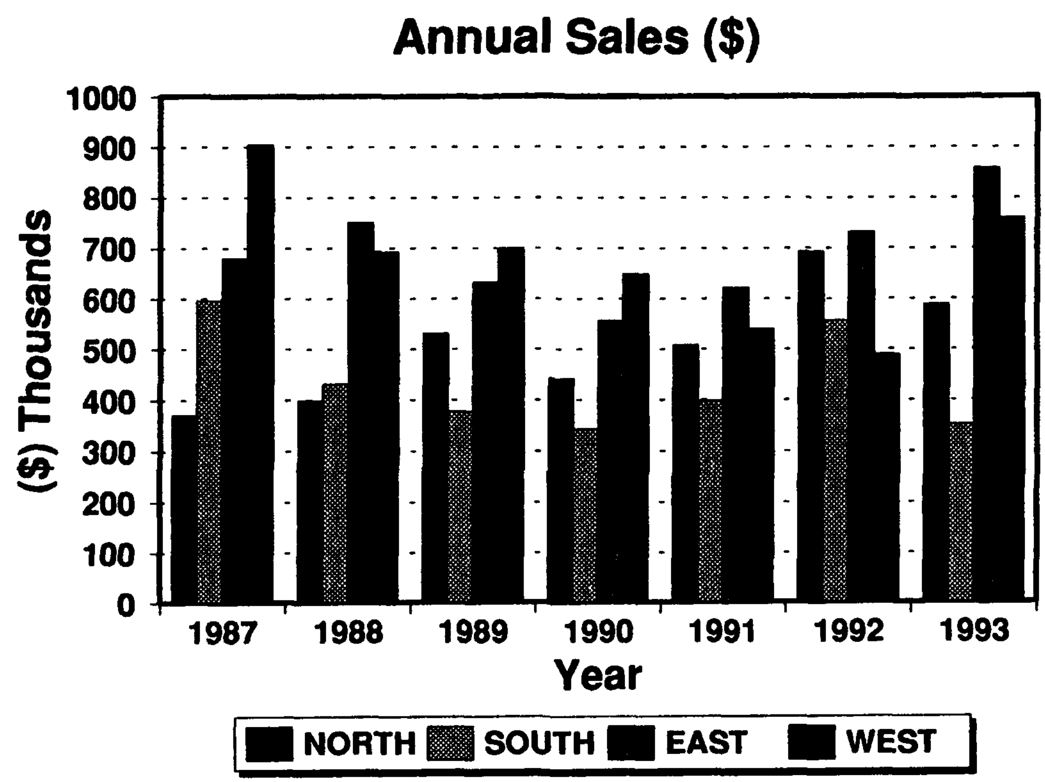
Region	North	South	East	West
Year				
1987	94	394	504	805
1988	132	176	597	521
1989	307	105	442	532
1990	189	57	340	463
1991	275	130	426	319
1992	520	340	572	251
1993	384	70	742	610

Which region had expenses less than $400 each year?
(1) North (2) South (3) East (4) West

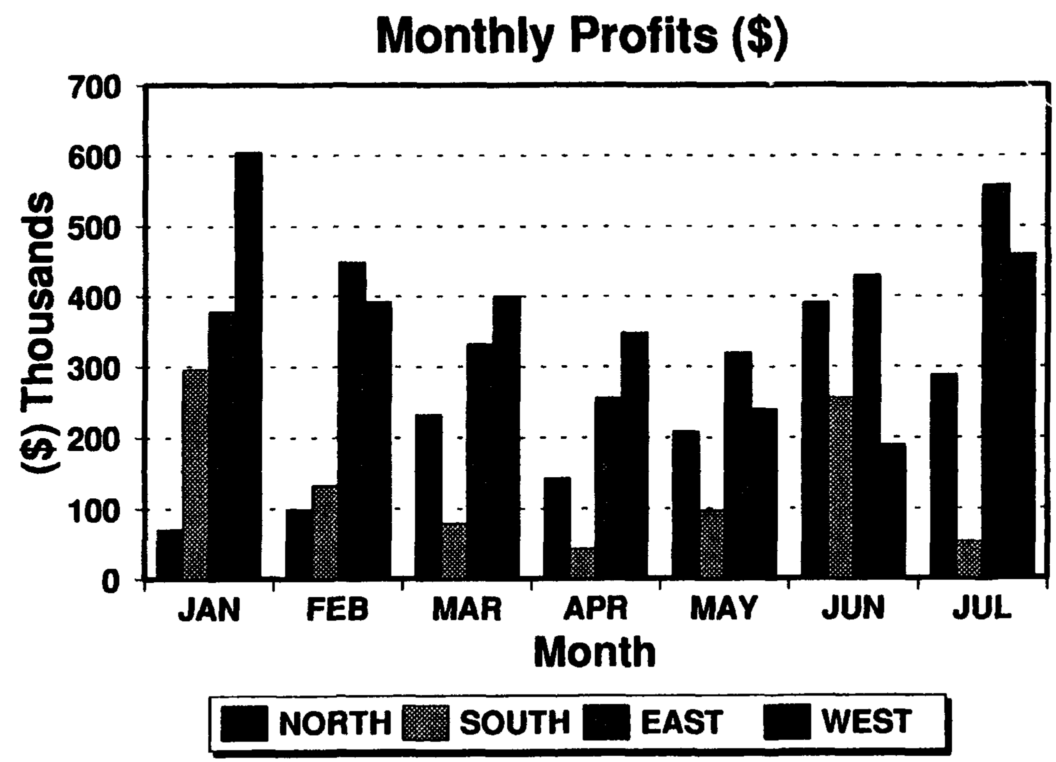
Monthly Costs ($ Thousands)

Region / Month	North	South	East	West
Jan	24	98	126	201
Feb	33	44	149	130
Mar	77	26	110	133
Apr	47	14	85	116
May	69	33	106	80
Jun	130	85	143	63
Jul	96	18	186	153

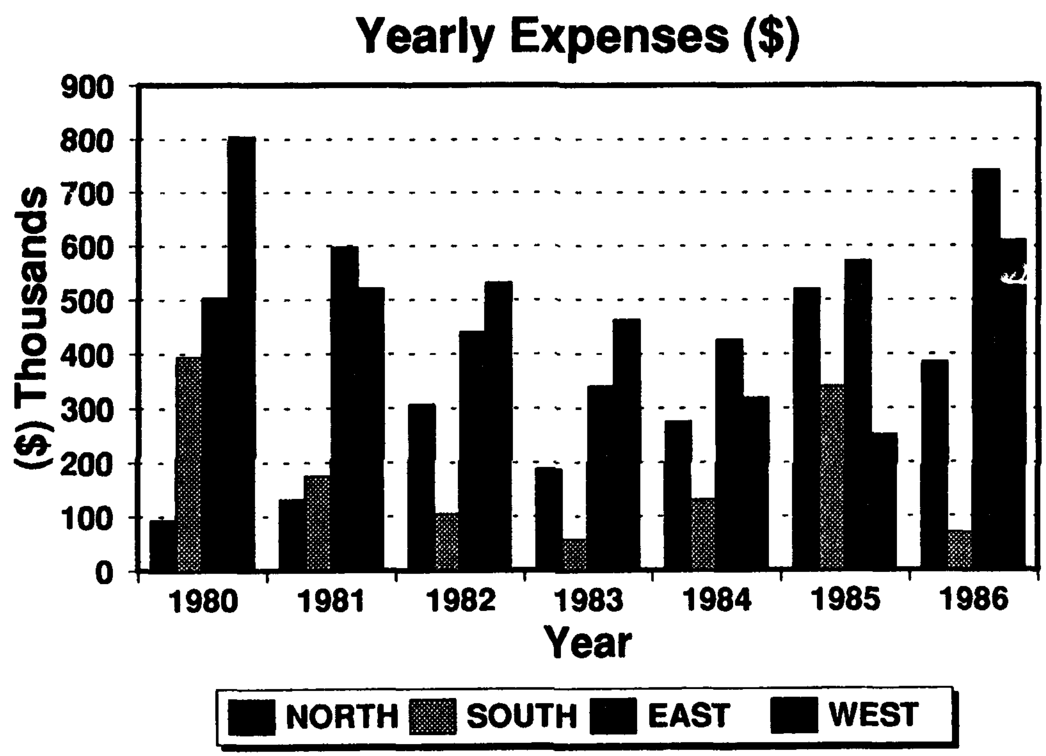
Which region had the largest change between two consecutive months?
(1) North (2) South (3) East (4) West



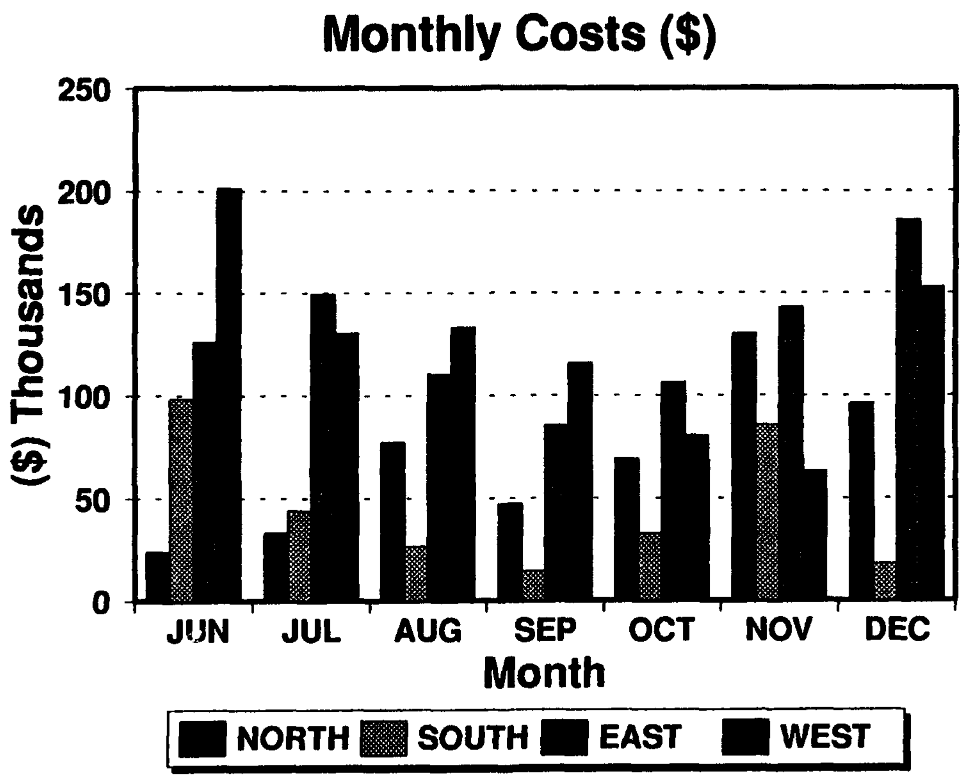
In 1989 which region's sales were closest to $600?
(1) North (2) South (3) East (4) West



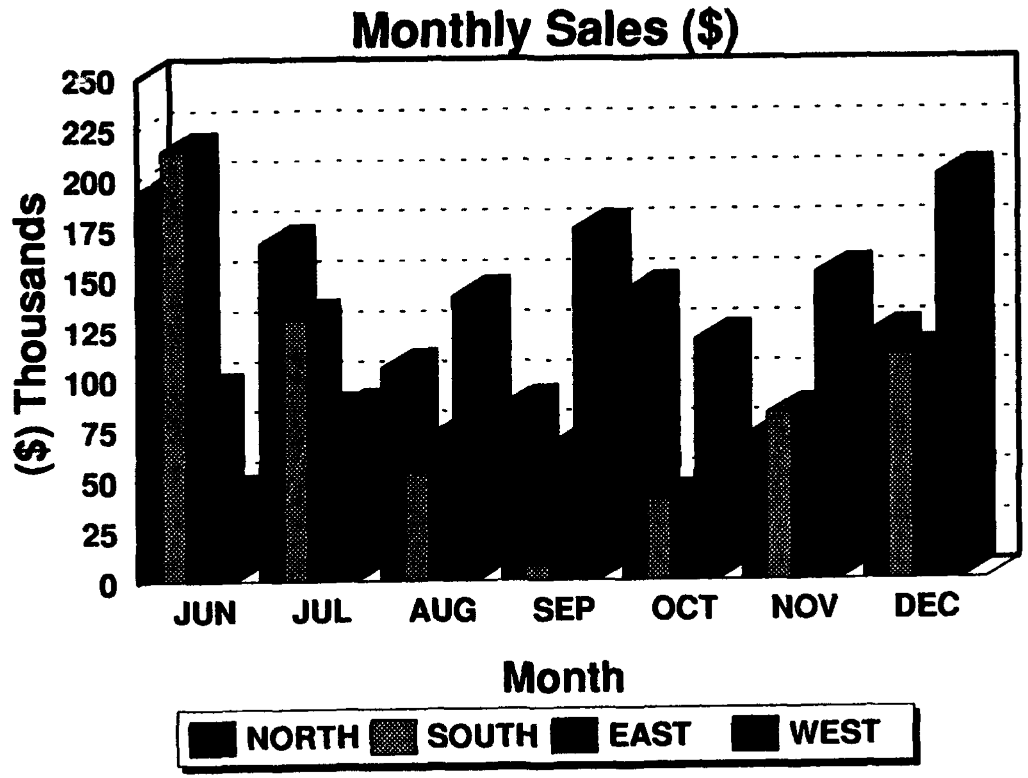
Which region's profits increased each month between Jan and Mar?
(1) North (2) South (3) East (4) West



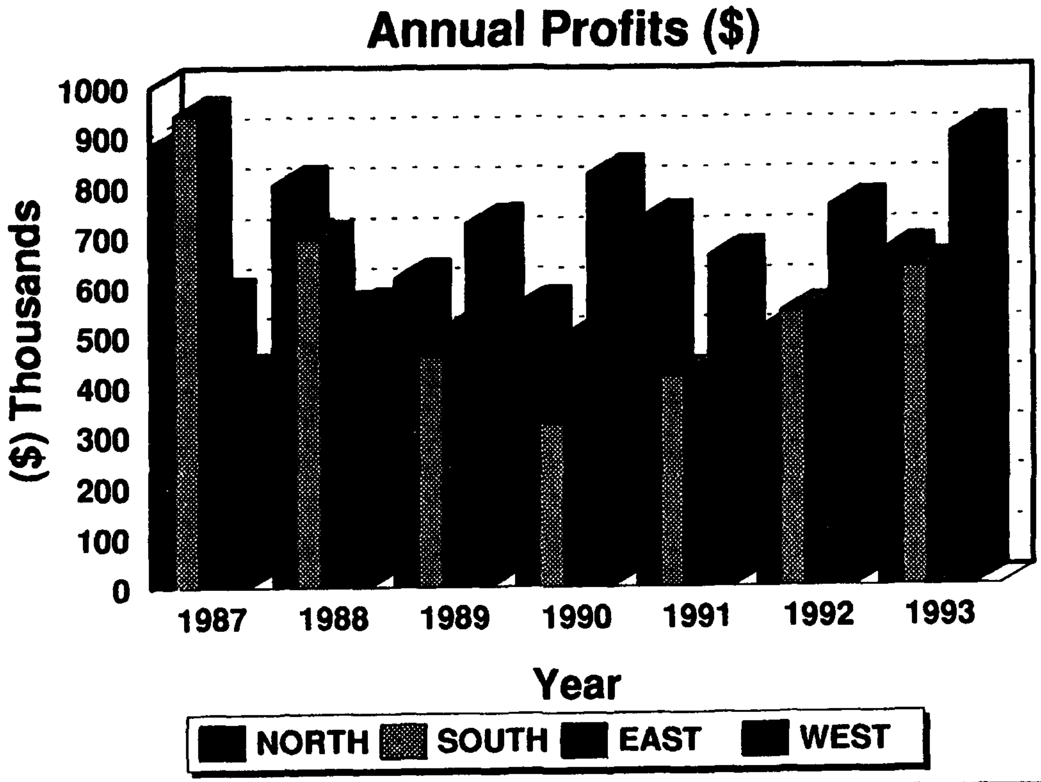
Which region had expenses less than $400 each year?
(1) North (2) South (3) East (4) West



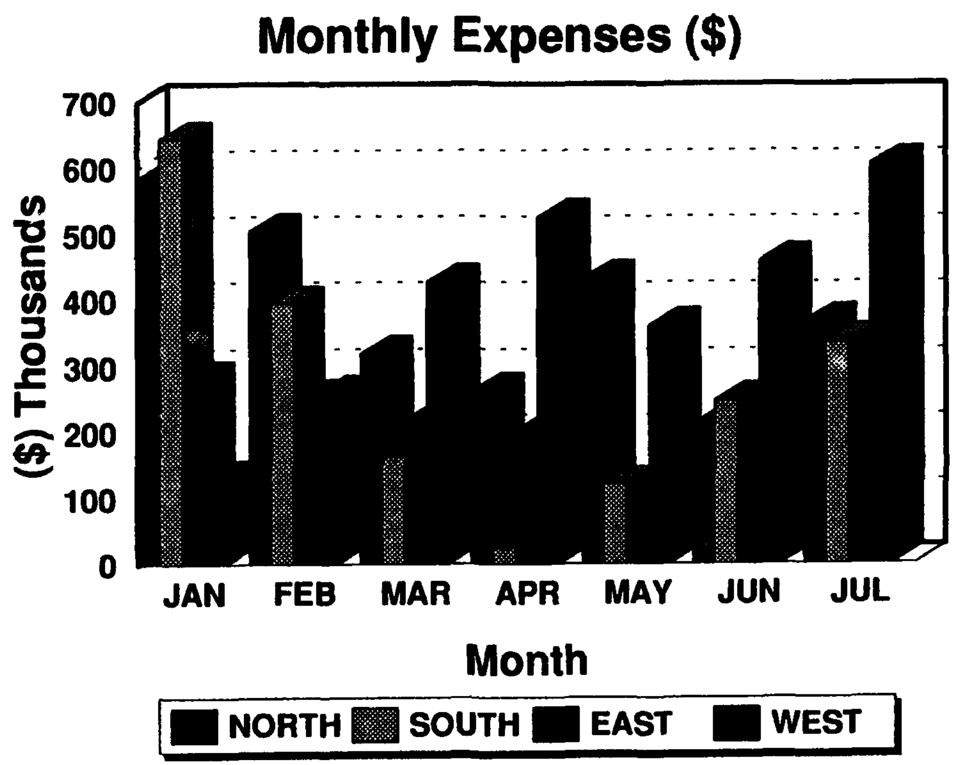
Which region had the largest change between two consecutive months?
(1) North (2) South (3) East (4) West



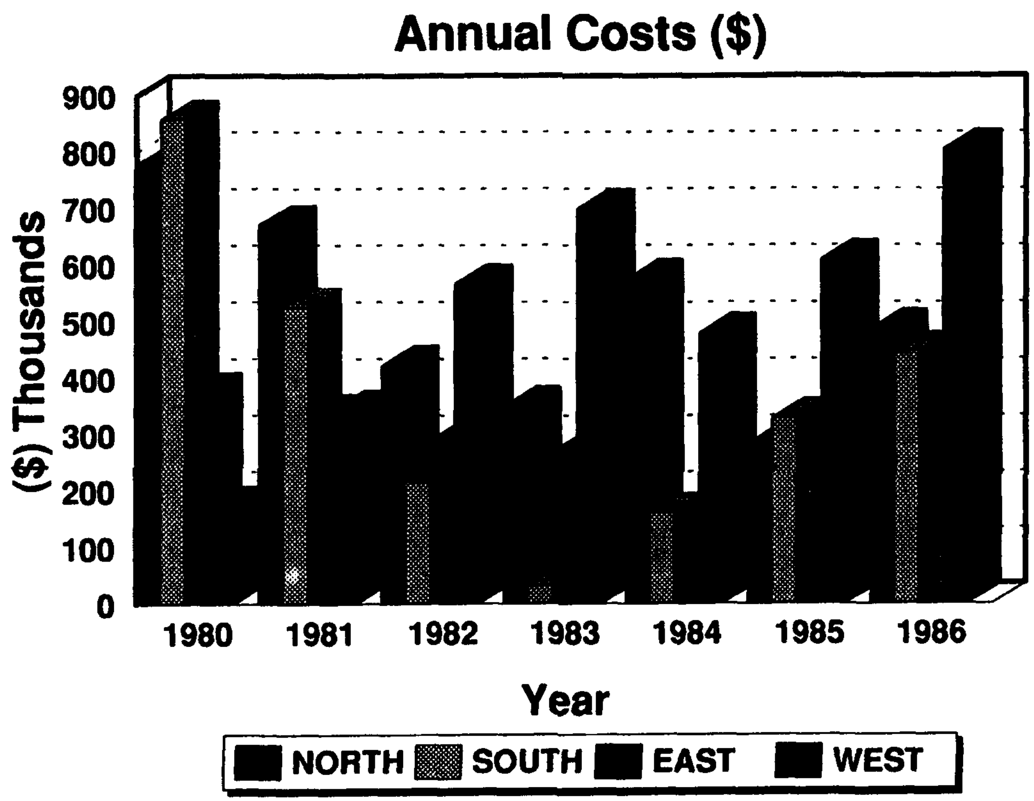
In Aug, which region's sales were nearest $1007
(1) North (2) South (3) East (4) West



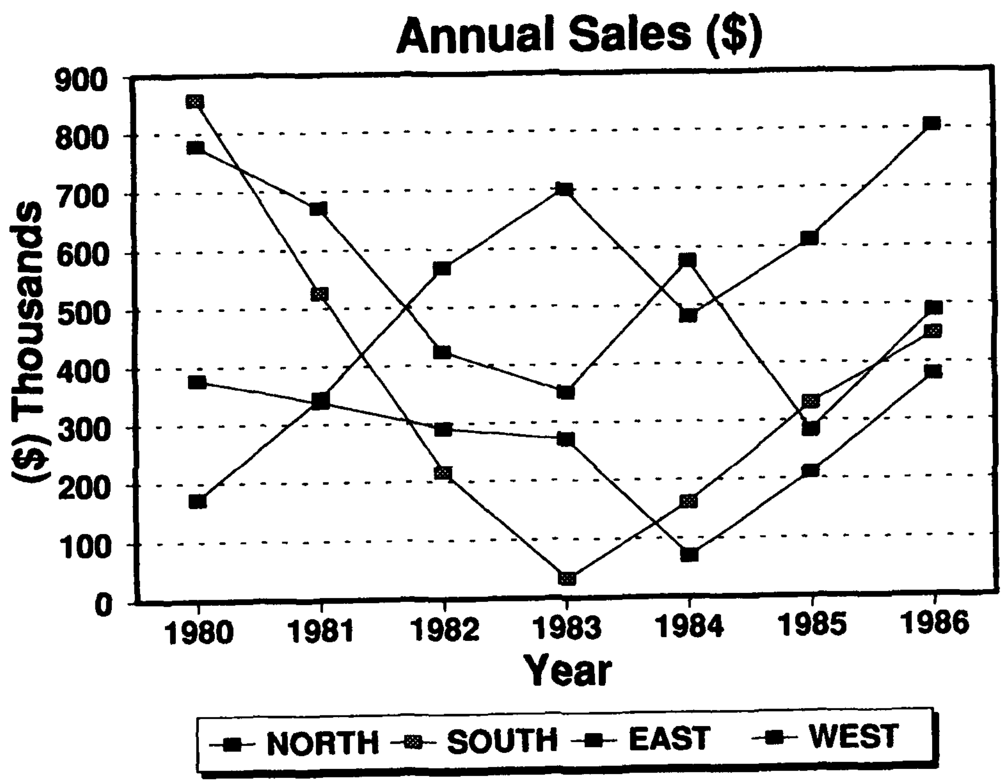
Which region's profits increased each year between 1987 and 1989?
(1) North (2) South (3) East (4) West



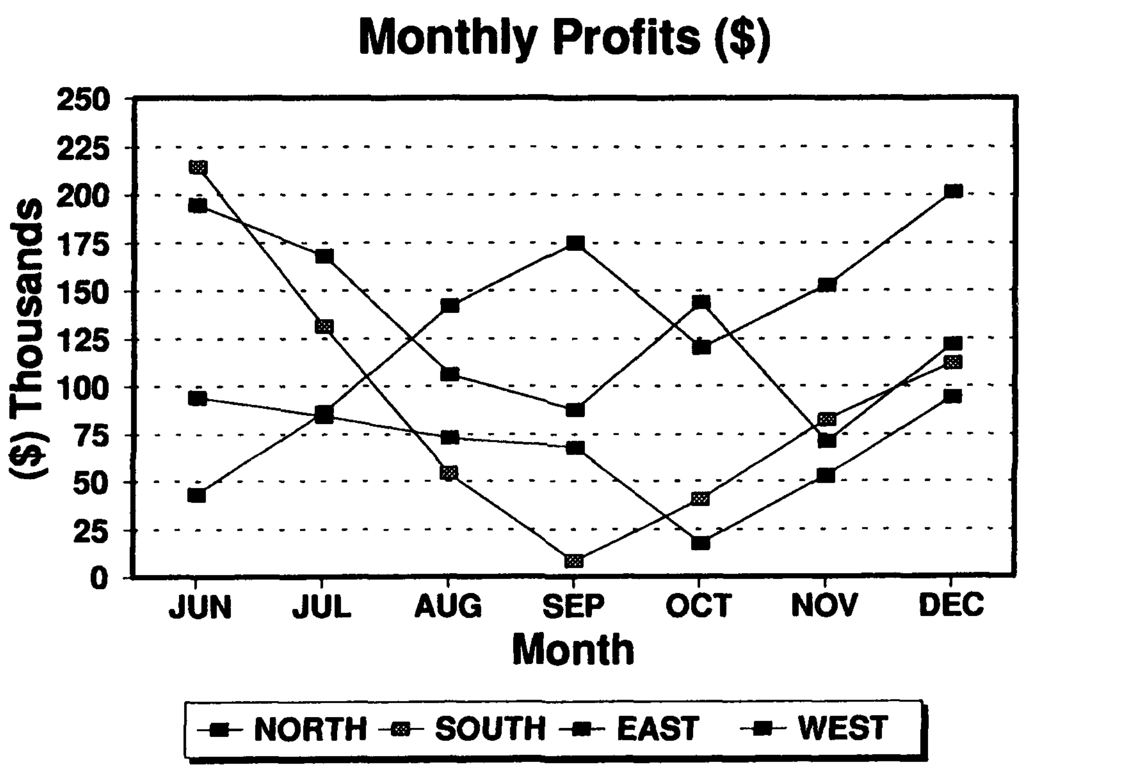
Which region had expenses less than $300 each month?
(1) North (2) South (3) East (4) West



Which region had the largest change between two consecutive years?
(1) North (2) South (3) East (4) West

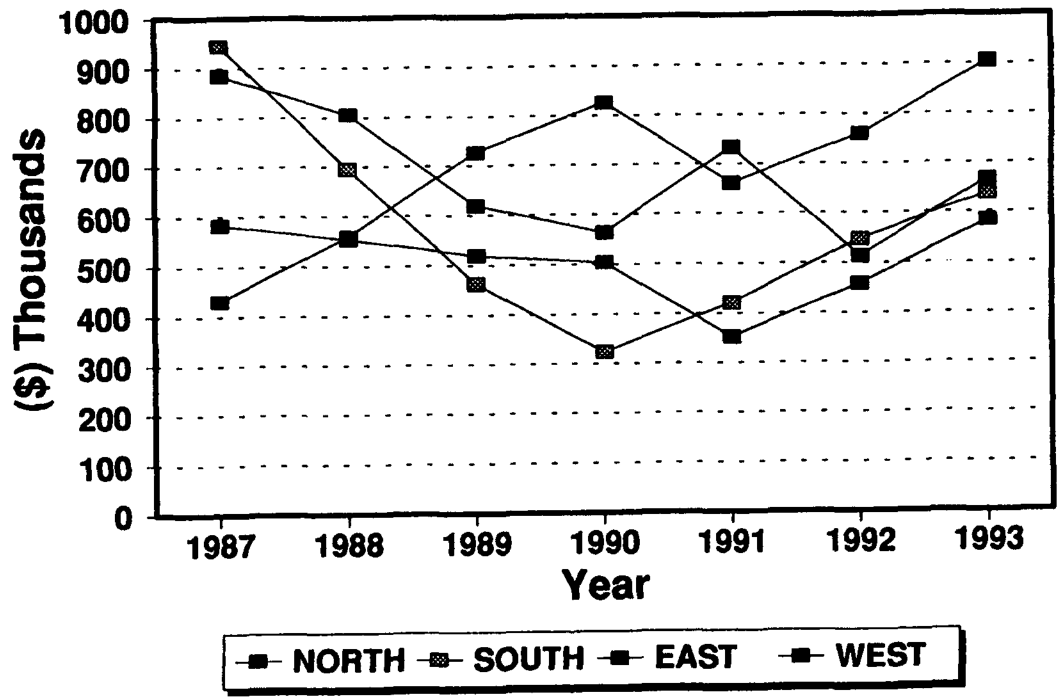


In 1982, which region's sales were closest to $400?
(1) North (2) South (3) East (4) West

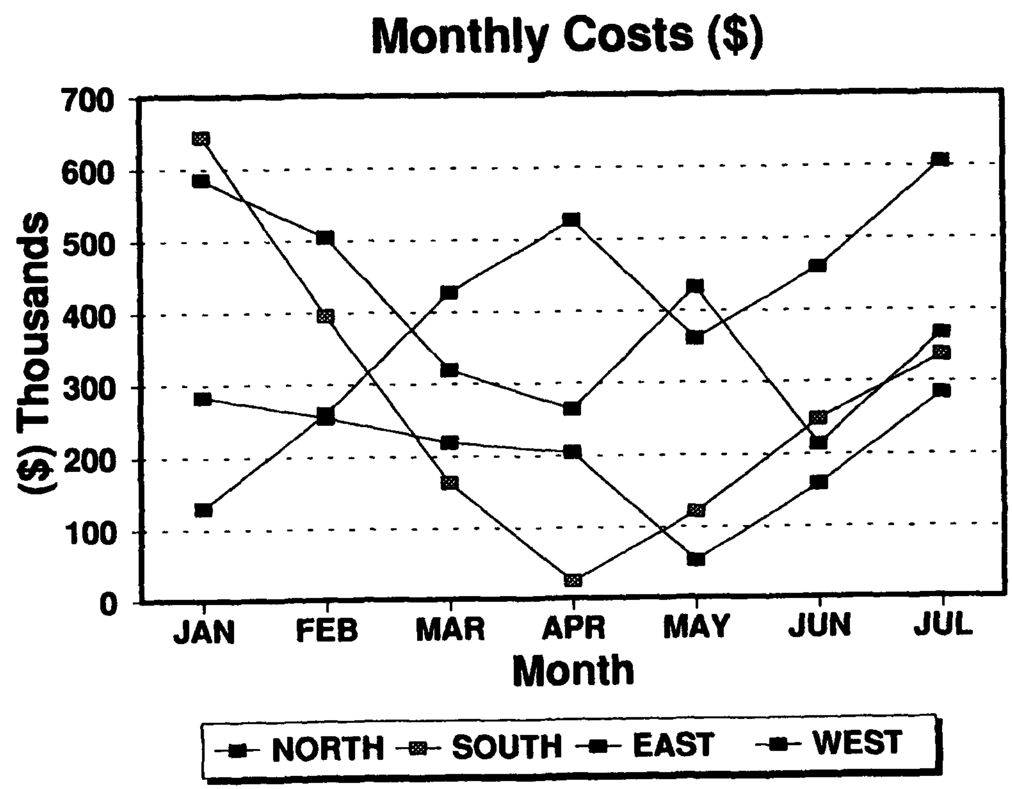


Which region's profits increased each month between Jun and Aug?
(1) North (2) South (3) East (4) West

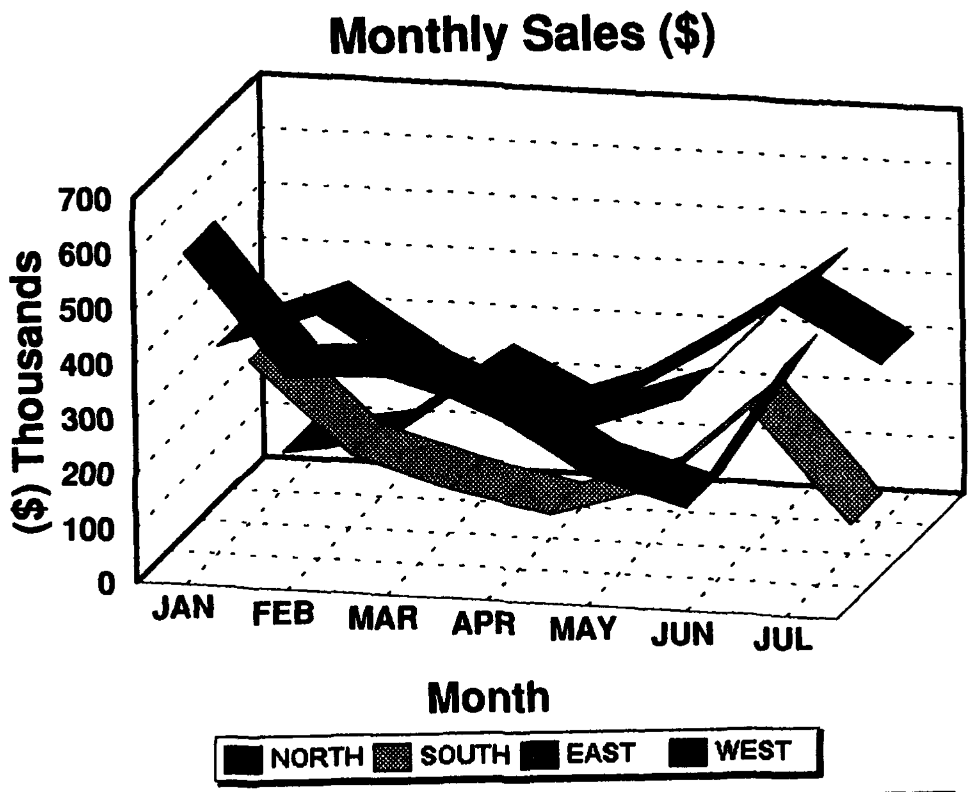
Yearly Expenses ($)



Which region had expenses less than $600 each year?
(1) North (2) South (3) East (4) West

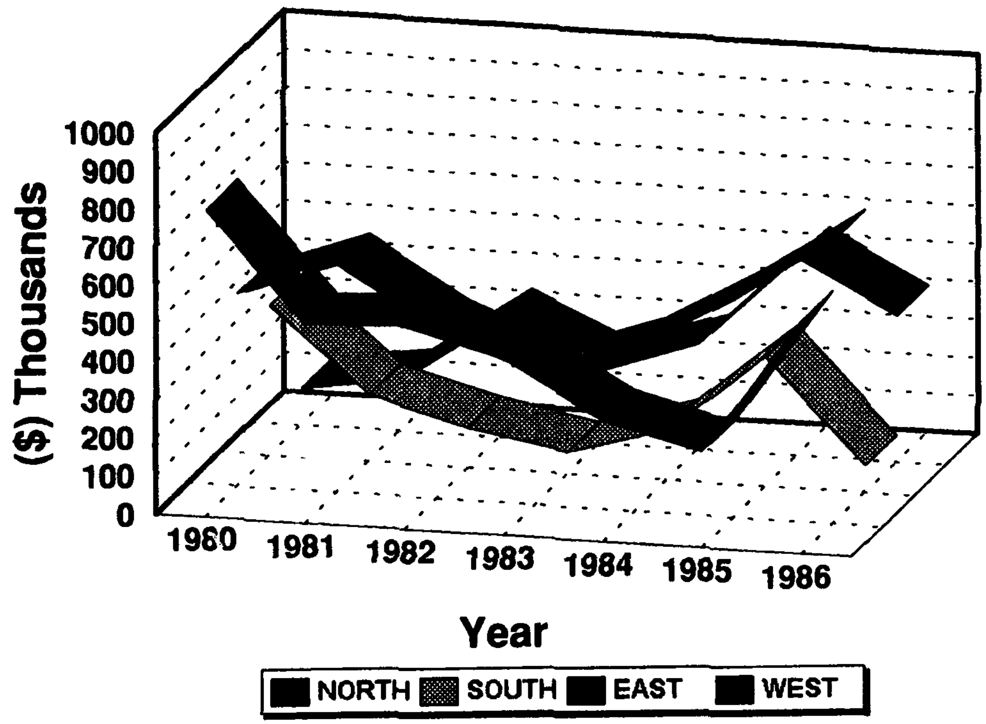


Which region had the largest change between two consecutive months?
(1) North (2) South (3) East (4) West

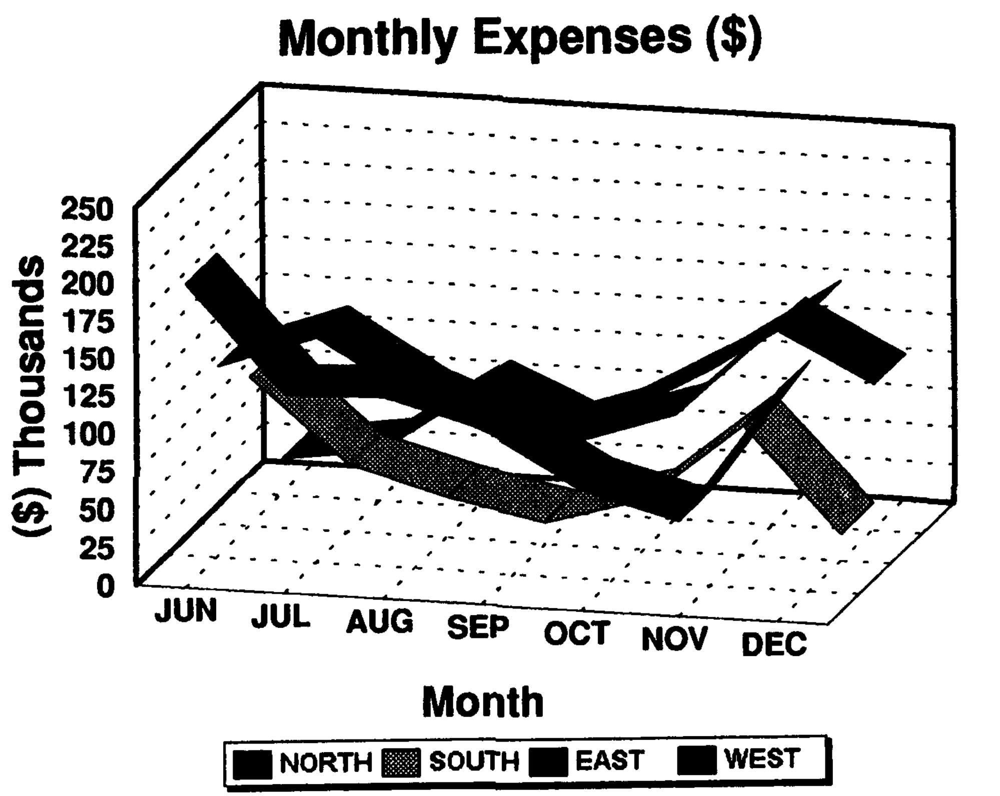


In Mar, which region's sales were nearest $300?
(1) North (2) South (3) East (4) West

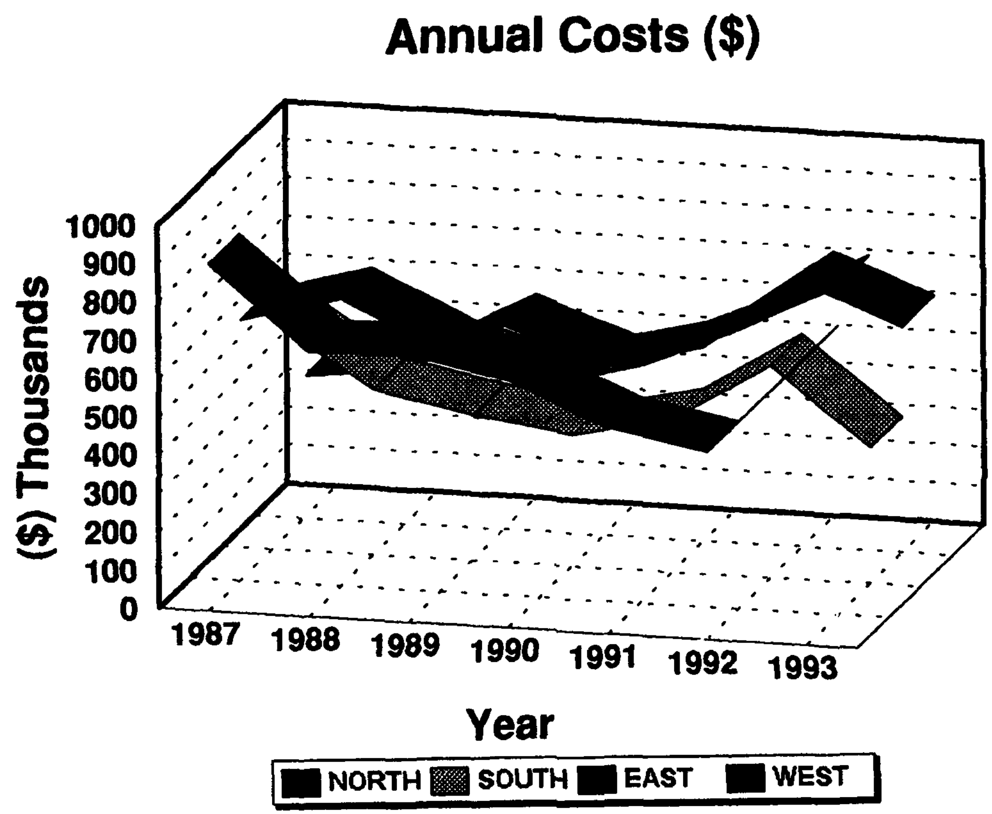
Annual Profits ($)



Which region's profits increased each year between 1980 and 1982?
(1) North (2) South (3) East (4) West



Which region had expenses less than $100 each month?
(1) North (2) South (3) East (4) West

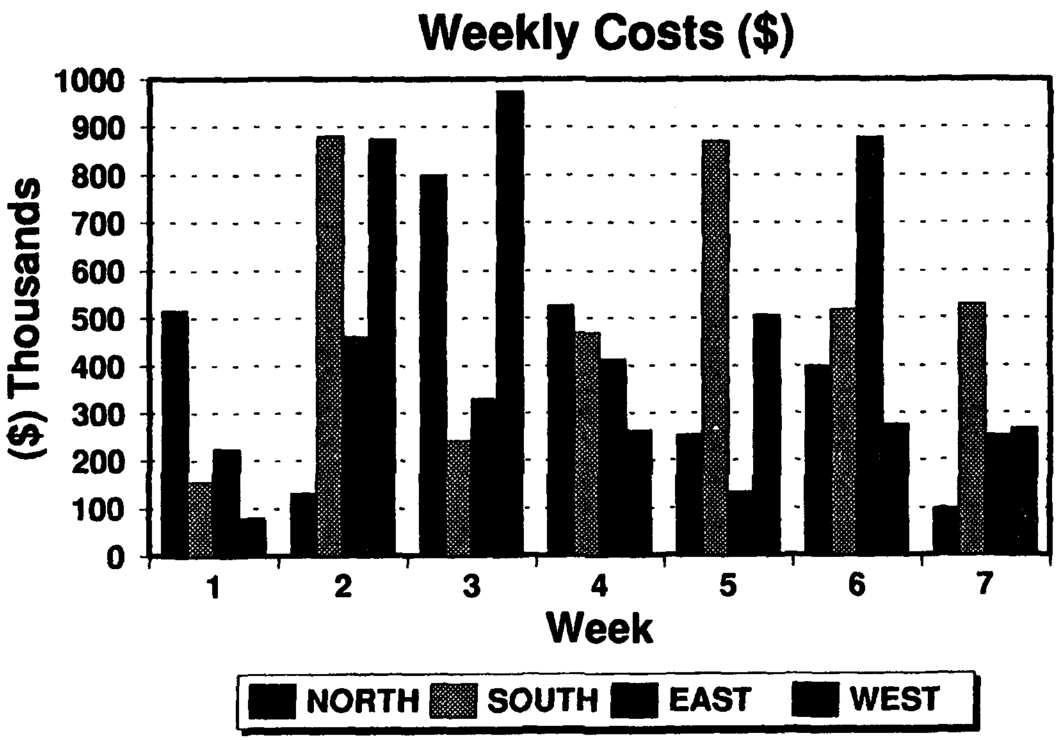


Which region had the largest change between two consecutive years?
(1) North (2) South (3) East (4) West

Weekly Profits ($ Thousands)

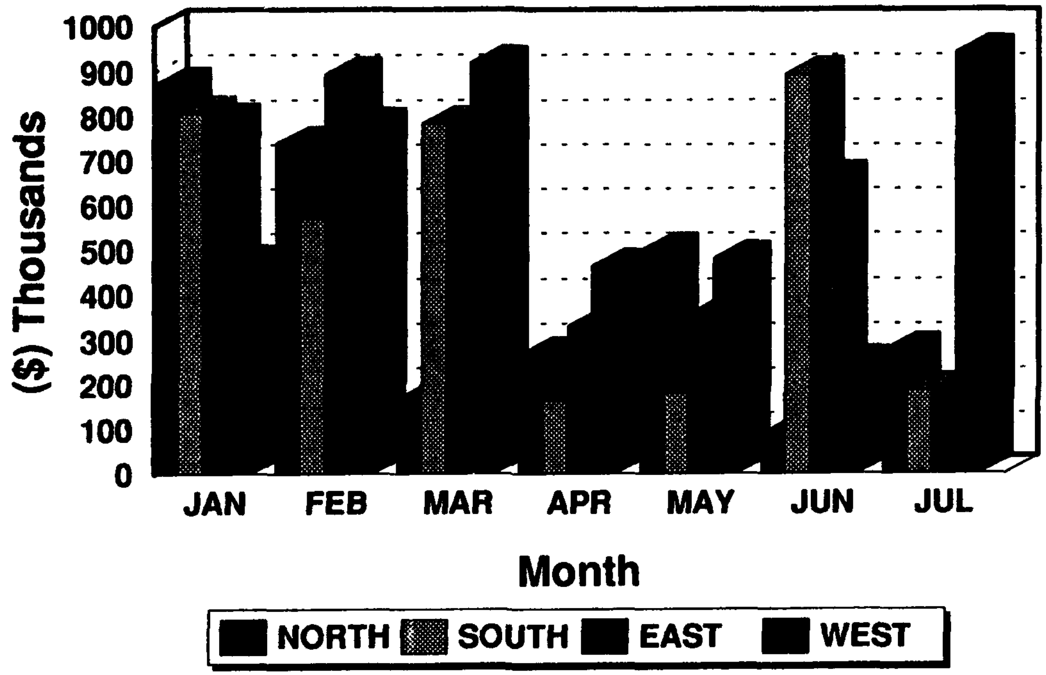
Region Week	North	South	East	West
1	516	156	724	75
2	131	880	460	873
3	800	241	329	975
4	527	469	473	262
5	253	870	133	506
6	399	518	877	275
7	98	528	252	267

Which region earned the lowest profits in week 4?
(1) North (2) South (3) East (4) West

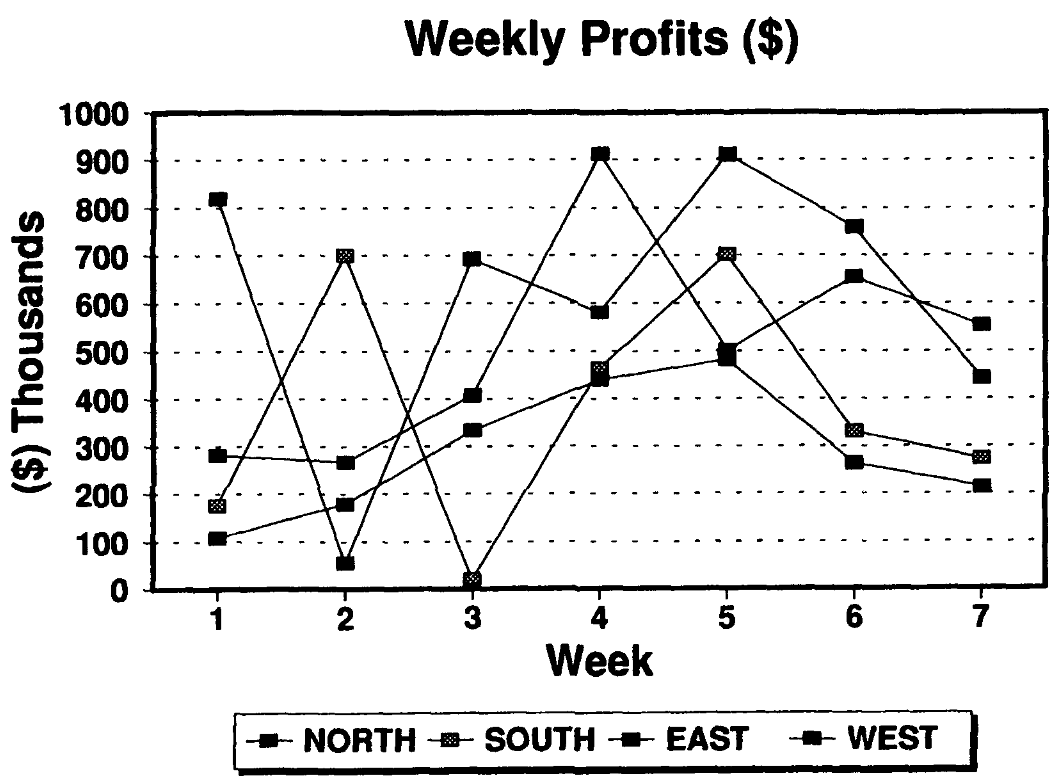


Which region had the highest cost in week 2?
(1) North (2) South (3) East (4) West

Monthly Costs ($)

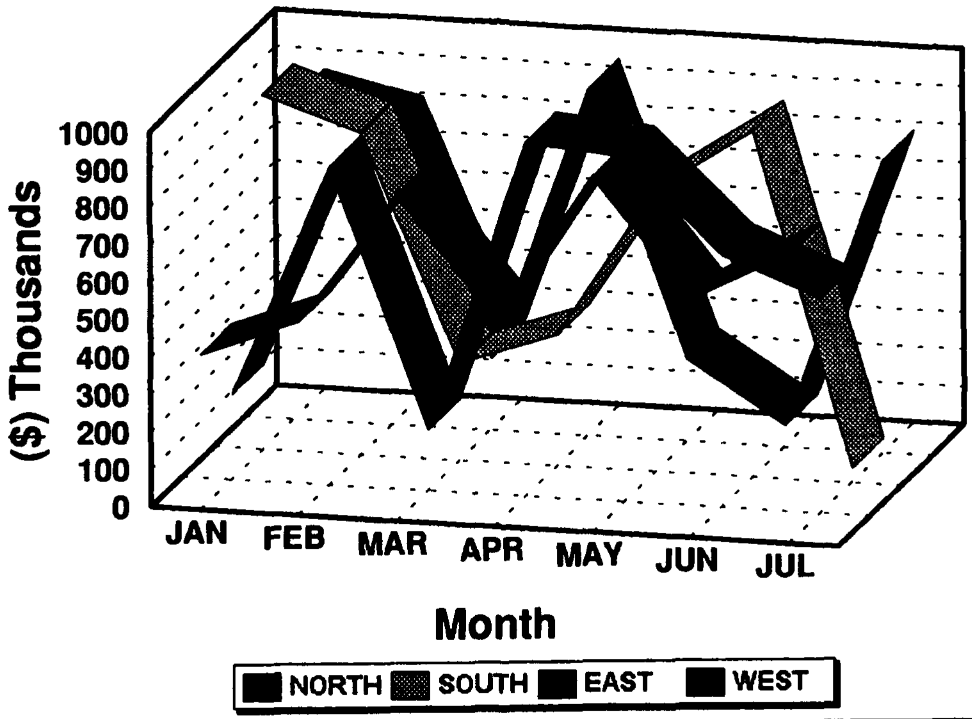


Which region had the greatest decrease in costs from May to Jun?
(1) North (2) South (3) East (4) West



Which region had the greatest decrease in profits between weeks 5 & 6?
(1) North (2) South (3) East (4) West

Monthly Sales ($)



Which region had the greatest sales increase from Mar to Apr?
(1) North (2) South (3) East (4) West

Financial information is provided for four regional offices: North, South, East and West. As the Vice-President for Armagedon Corporation, you have asked for financial information from the last seven periods for each of the four regional offices. Your job is to assess and compare the financial information for each of these regions to determine if there are any problems. Information will be presented in 25 charts (graphs and tables).

Each of the four regions has an equitable sales base and has approximately the same number of customers. In other words they are on a "level playing field."

Please select the most appropriate answer from the choices provided and type the number (only once) associated with the chosen answer. The computer will automatically go to the next screen. Please be aware there may be a slight delay.

The total time for the exercise should not exceed approximately 15 minutes. Please press any key to continue!

Annual Sales ($ Thousands)

Region Year	North	South	East	West
1987	885	945	583	430
1988	805	695	554	559
1989	619	463	519	727
1990	564	324	504	826
1991	733	421	353	661
1992	513	548	459	759
1993	667	637	584	905

In 1989, which region's sales were closest to $600?
(1) North (2) South (3) East (4) West

Monthly Profits ($ Thousands)

Region / Month	North	South	East	West
Jan	585	645	283	130
Feb	505	395	253	259
Mar	319	163	219	427
Apr	264	24	203	526
May	433	121	52	361
Jun	213	248	159	459
Jul	367	337	284	605

Which region's profits increased each month between Jan and Mar?
(1) North (2) South (3) East (4) West

Yearly Expenses ($ Thousands)

Region / Year	North	South	East	West
1987	778	858	376	173
1988	672	525	337	344
1989	424	217	291	568
1990	351	32	271	700
1991	576	161	70	481
1992	283	330	211	610
1993	488	448	378	805

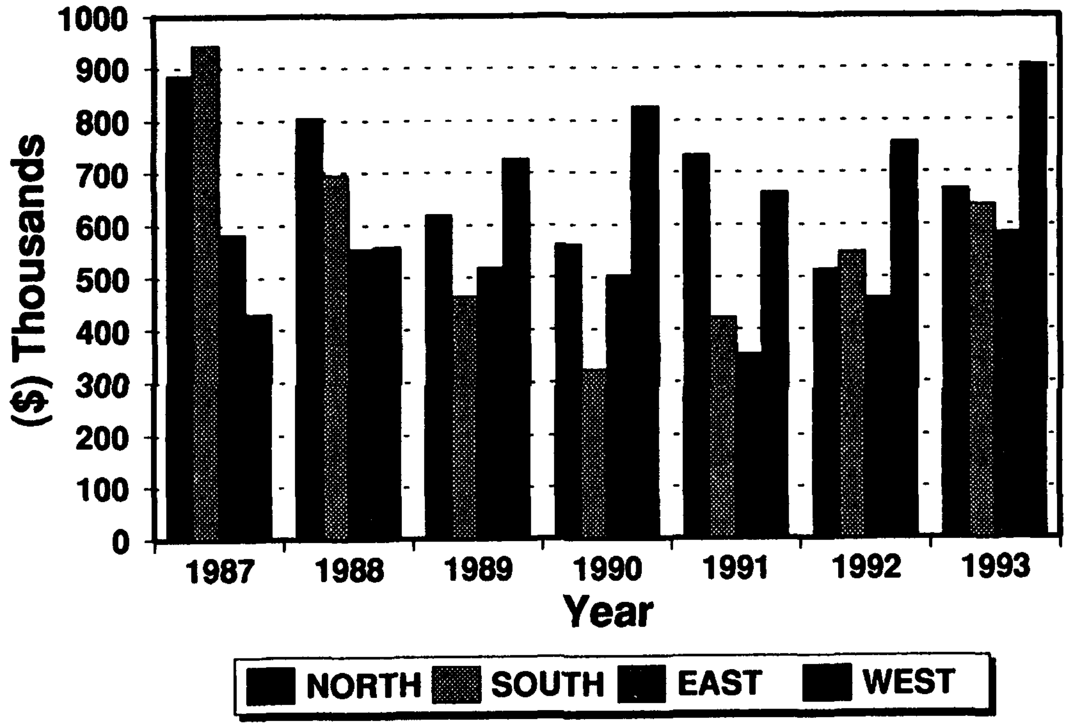
Which region had expenses less than $400 each year?
(1) North (2) South (3) East (4) West

Monthly Costs ($ Thousands)

Region / Month	North	South	East	West
Jan	195	214	94	43
Feb	168	131	84	86
Mar	106	54	73	142
Apr	88	8	68	175
May	144	40	18	120
Jun	71	82	53	153
Jul	122	112	94	201

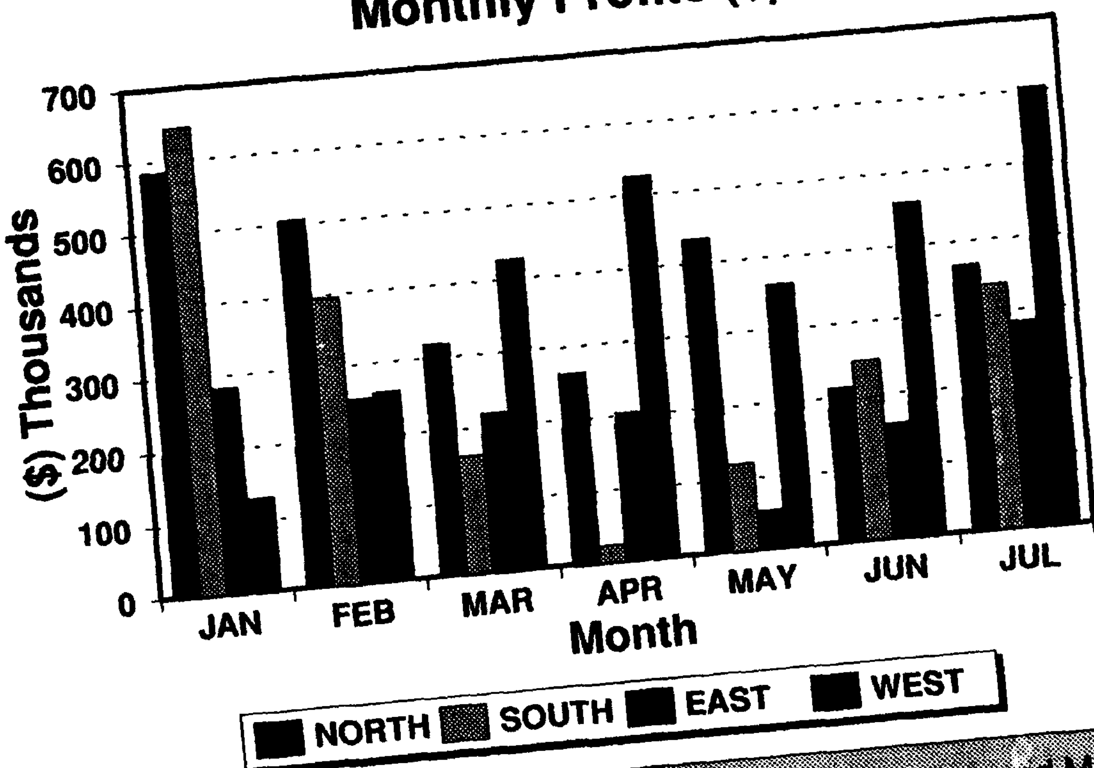
Which region had the largest change between two consecutive months?
(1) North (2) South (3) East (4) West

Annual Sales ($)

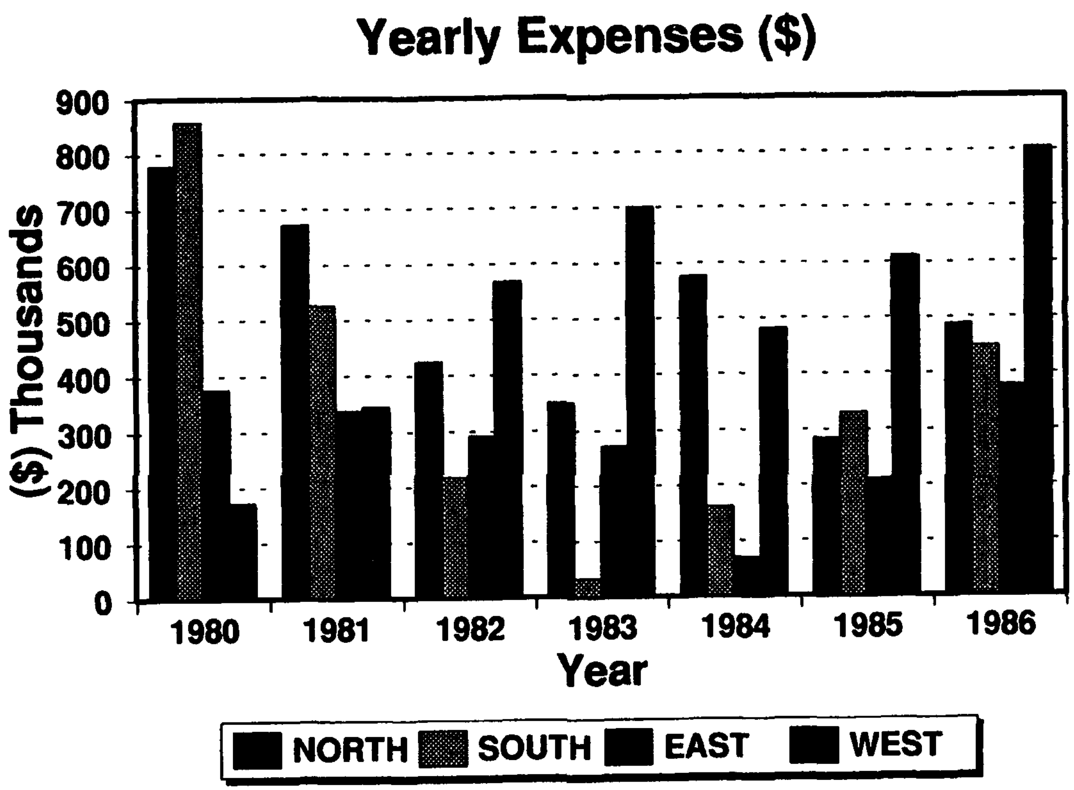


In 1989 which region's sales were closest to $600?
(1) North (2) South (3) East (4) West

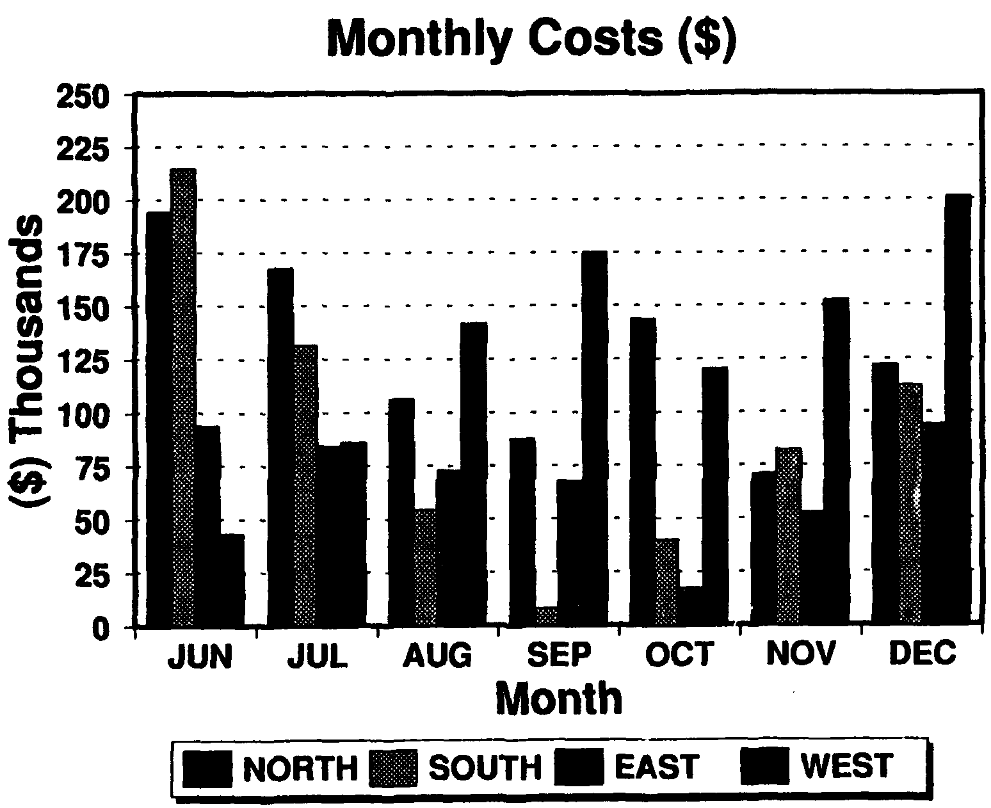
Monthly Profits ($)



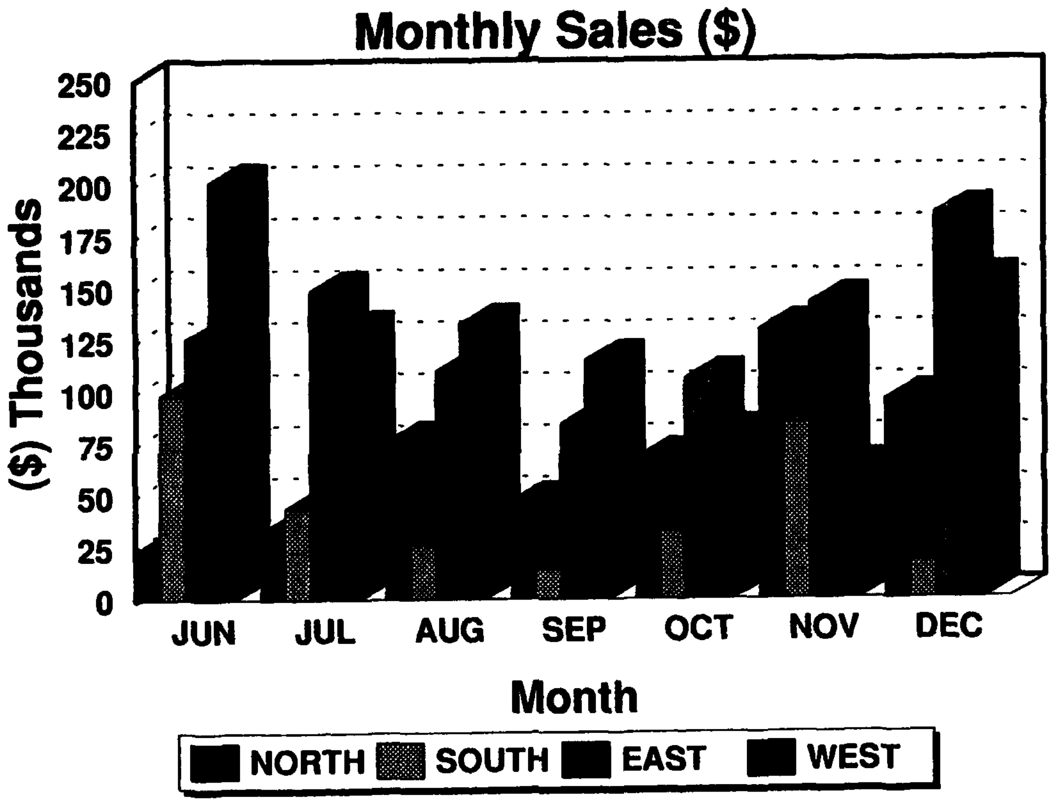
Which region's profits increased each month between Jan and Mar?
(1) North (2) South (3) East (4) West



Which region had expenses less than $400 each year?
(1) North (2) South (3) East (4) West

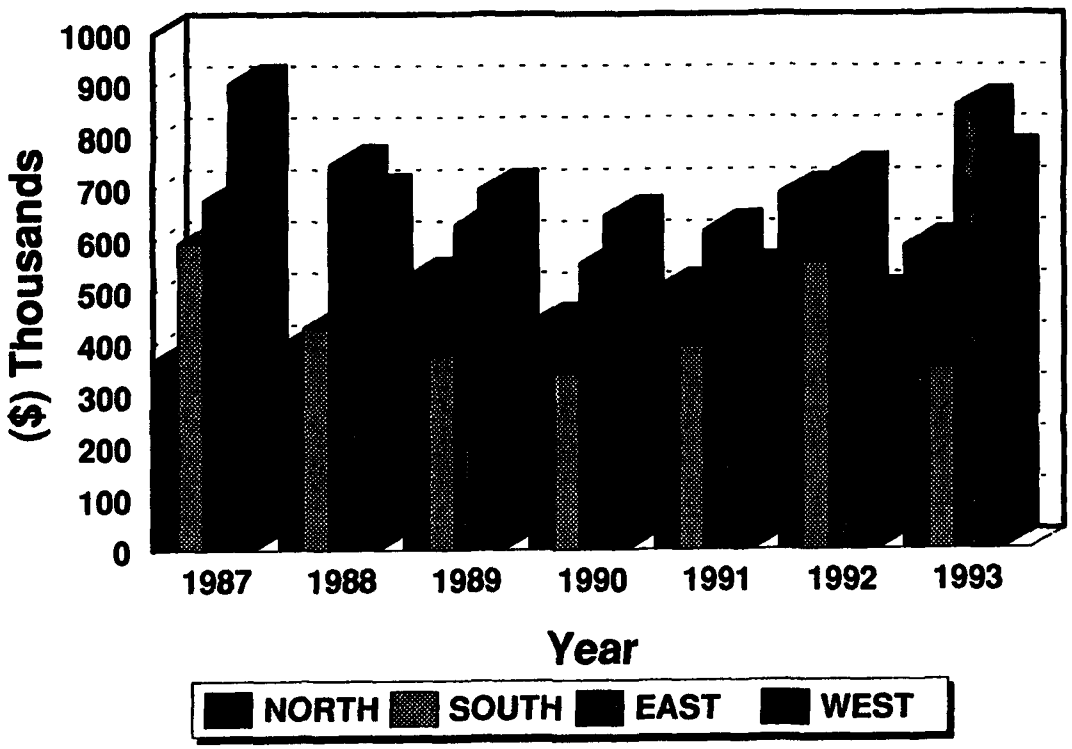


Which region had the largest change between two consecutive months?
(1) North (2) South (3) East (4) West

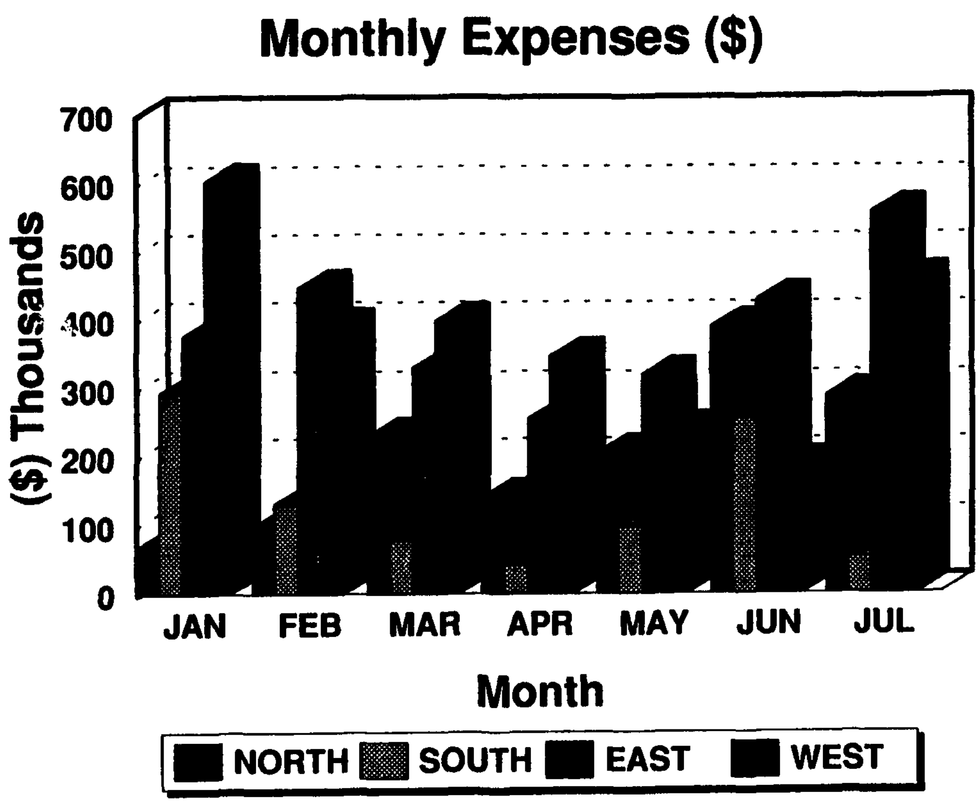


In Aug, which region's sales were nearest $100?
(1) North (2) South (3) East (4) West

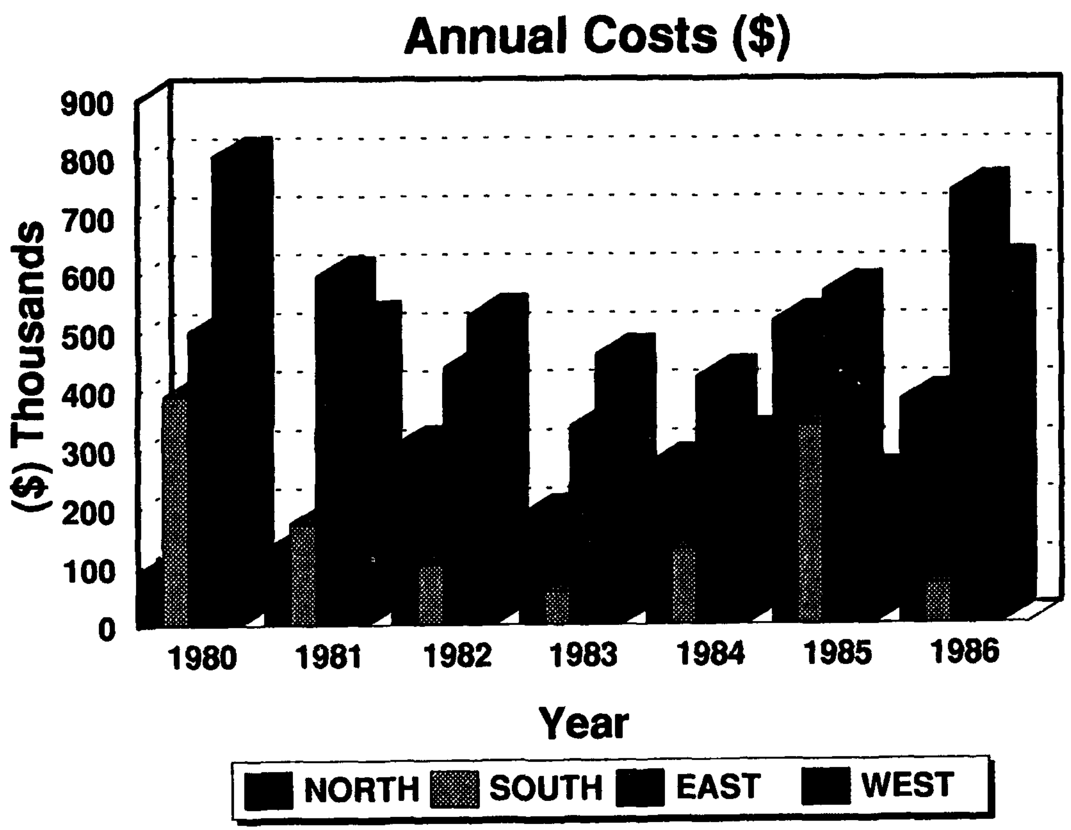
Annual Profits ($)



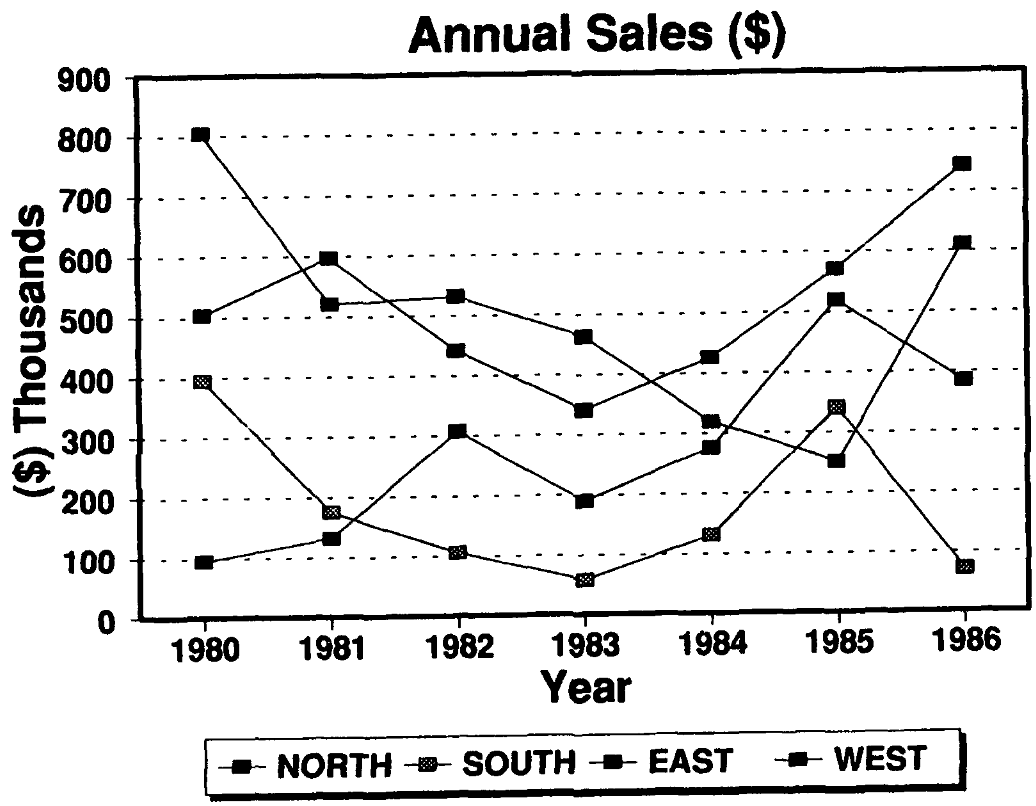
Which region's profits increased each year between 1987 and 1989?
(1) North (2) South (3) East (4) West



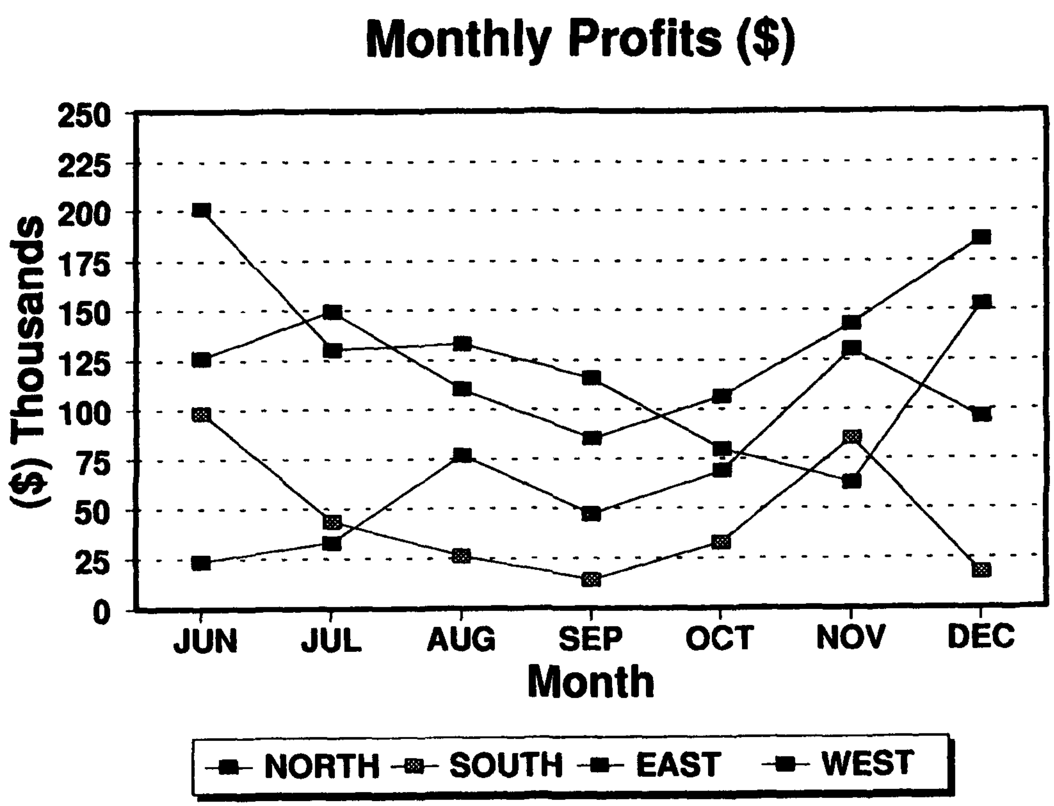
Which region had expenses less than $300 each month?
(1) North (2) South (3) East (4) West



Which region had the largest change between two consecutive years?
(1) North (2) South (3) East (4) West

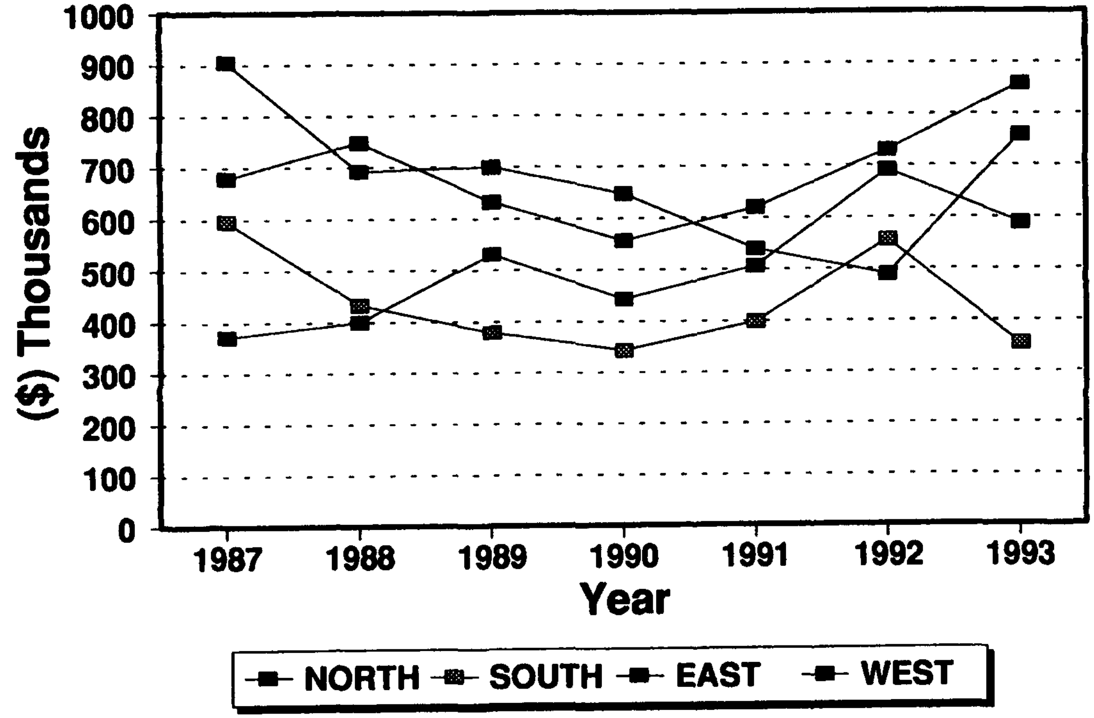


In 1982, which region's sales were closest to $400?
(1) North (2) South (3) East (4) West

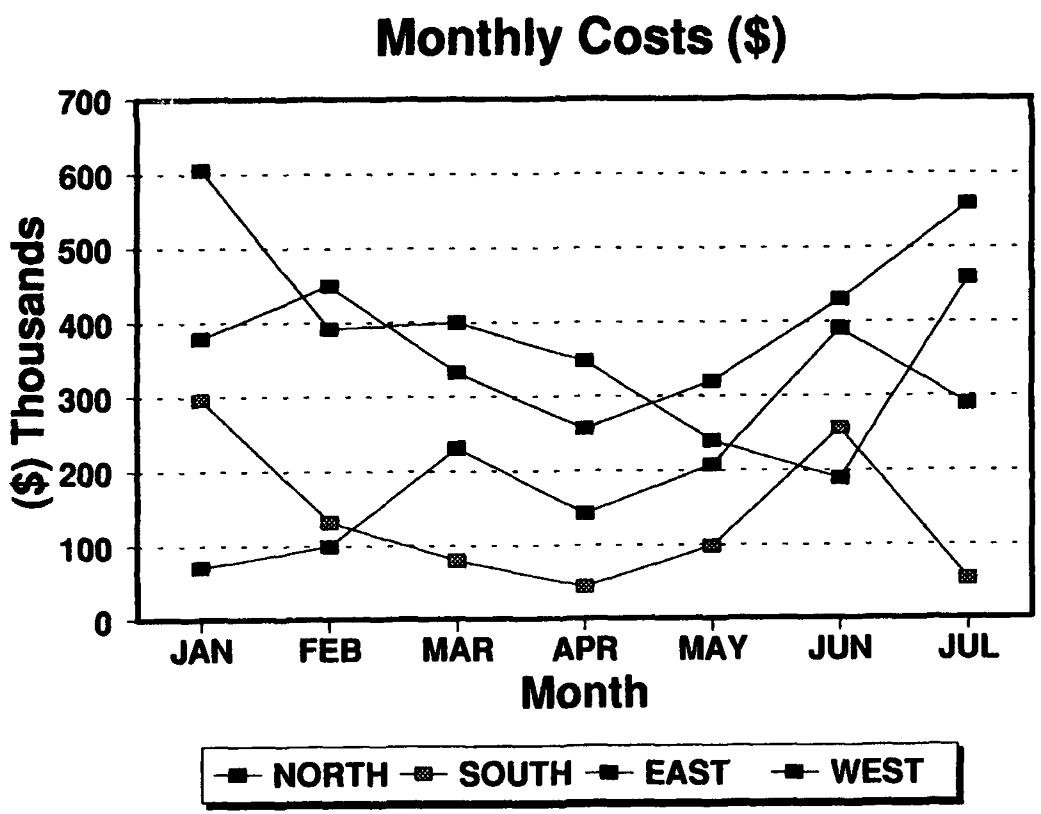


Which region's profits increased each month between Jun and Aug?
(1) North (2) South (3) East (4) West

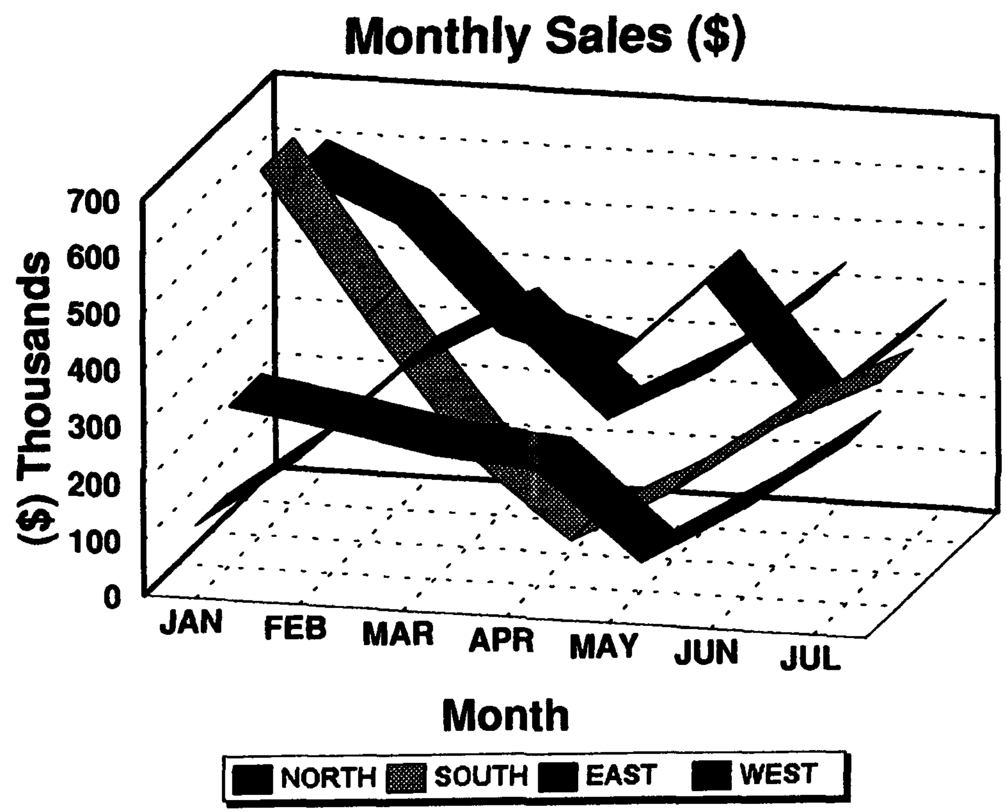
Yearly Expenses ($)



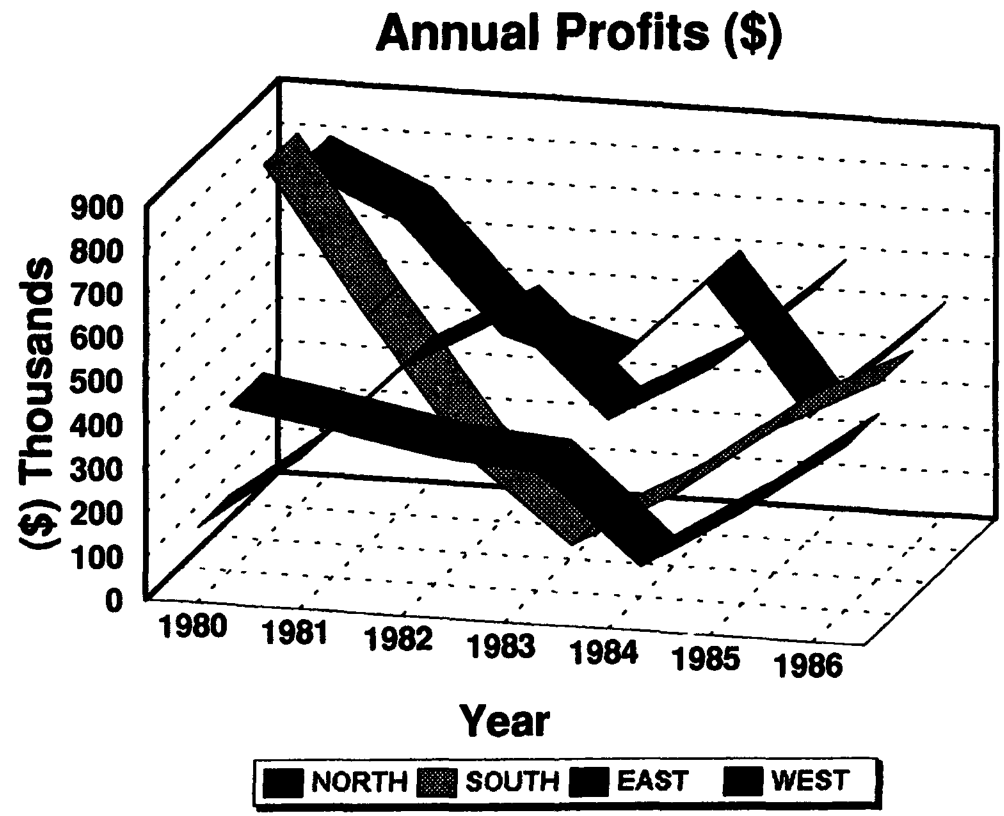
Which region had expenses less than $600 each year?
(1) North (2) South (3) East (4) West



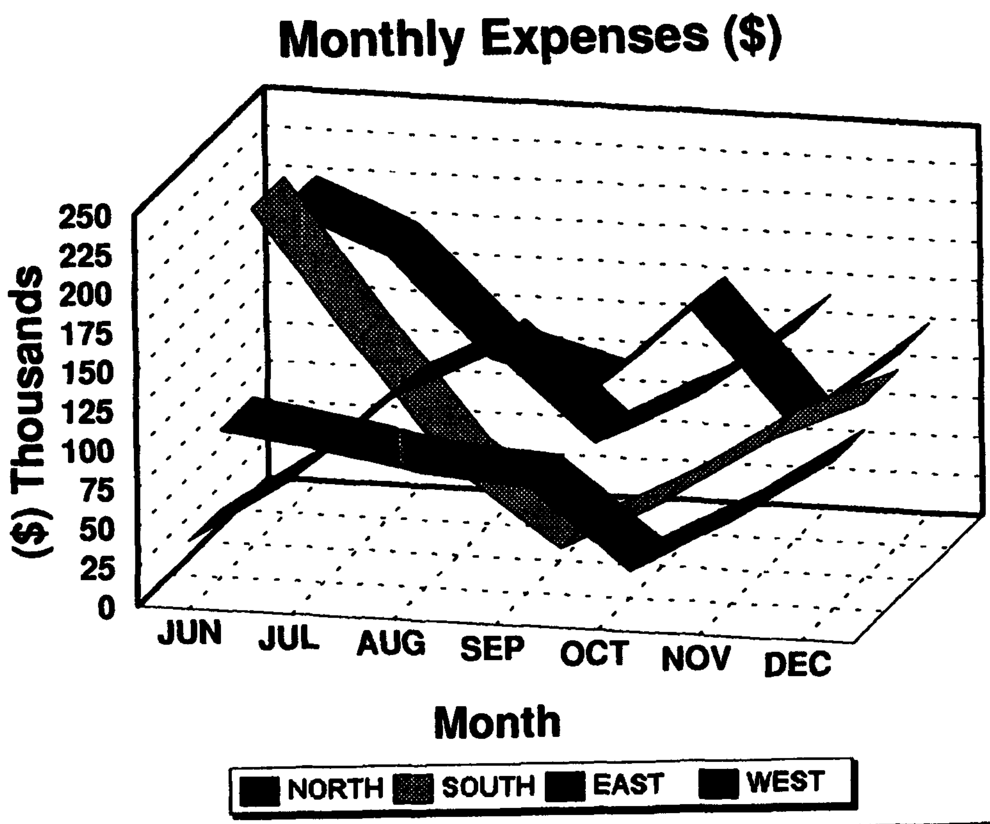
Which region had the largest change between two consecutive months?
(1) North (2) South (3) East (4) West



In Mar, which region's sales were nearest $300?
(1) North (2) South (3) East (4) West

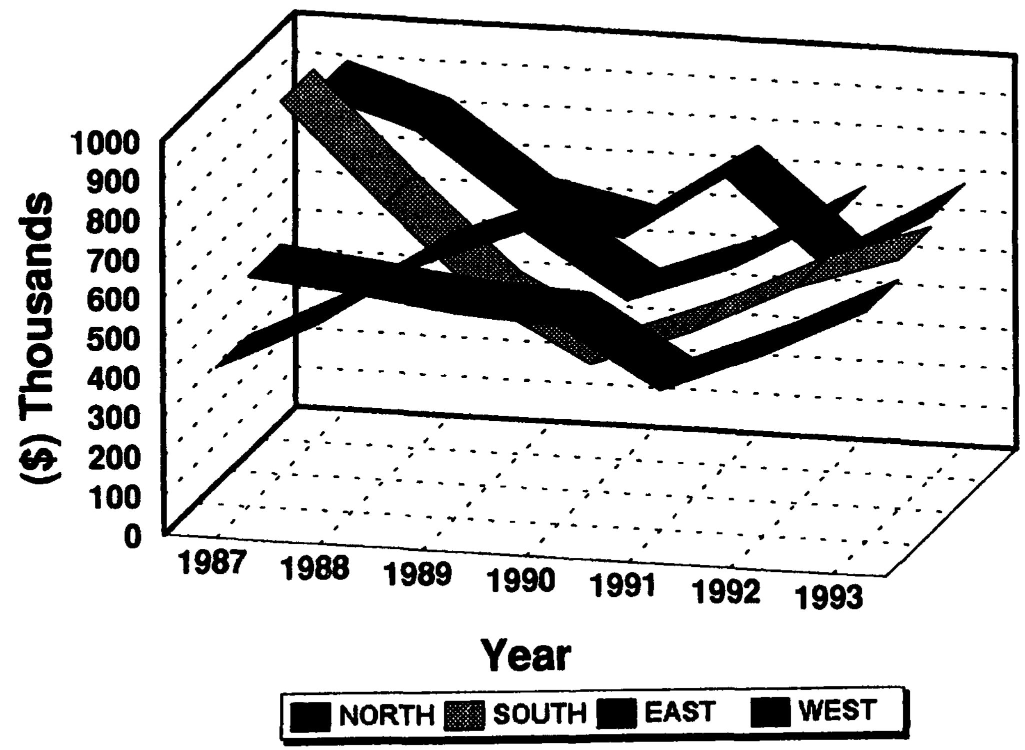


Which region's profits increased each year between 1980 and 1982?
(1) North (2) South (3) East (4) West



Which region had expenses less than $100 each month?
(1) North (2) South (3) East (4) West

Annual Costs ($)



Which region had the largest change between two consecutive years?
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Weekly Profits ($ Thousands)

Region / Week	North	South	East	West
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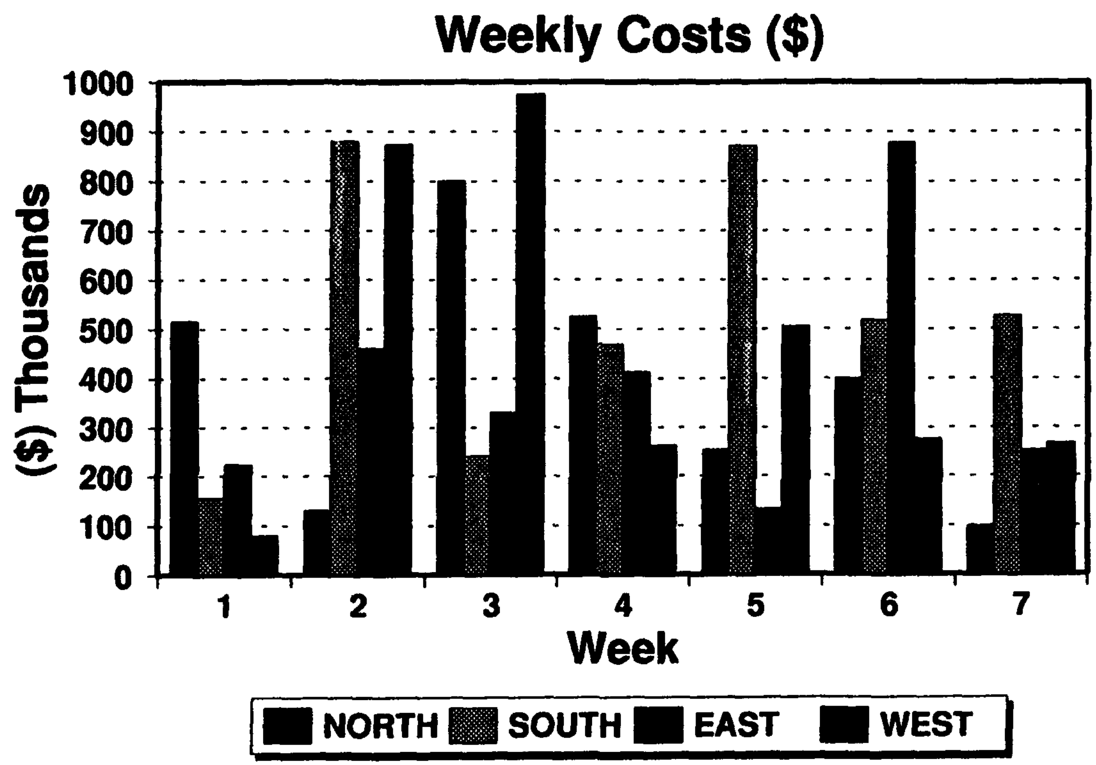
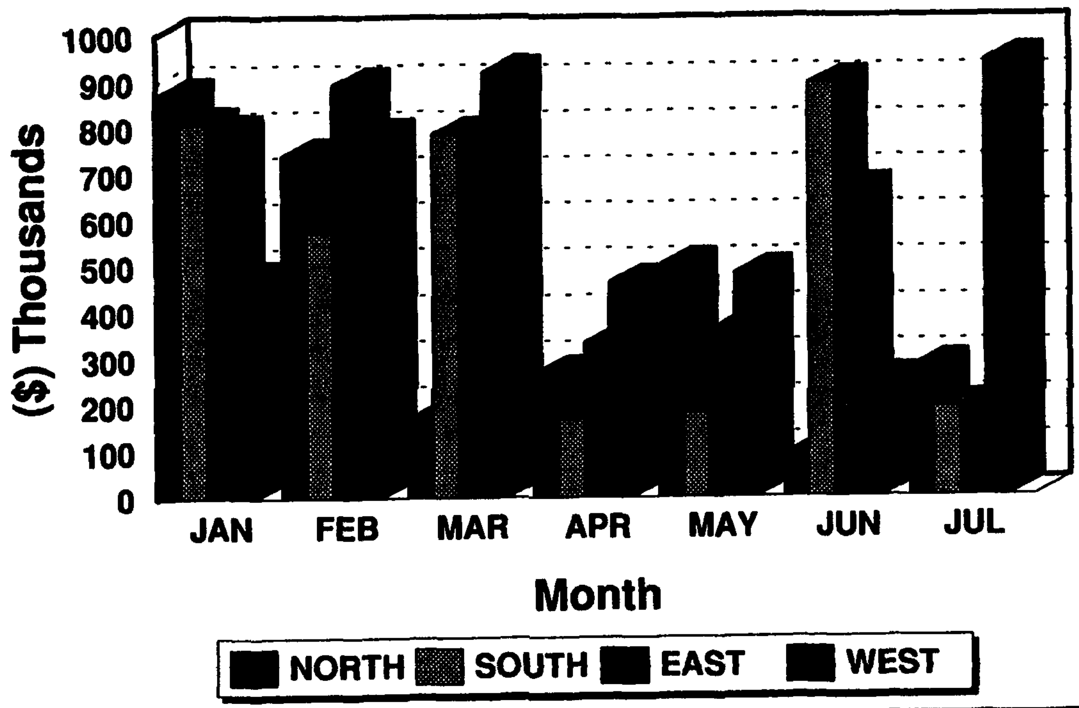
7	98	528	252	267

Which region earned the lowest profits in week 4?
(1) North (2) South (3) East (4) West

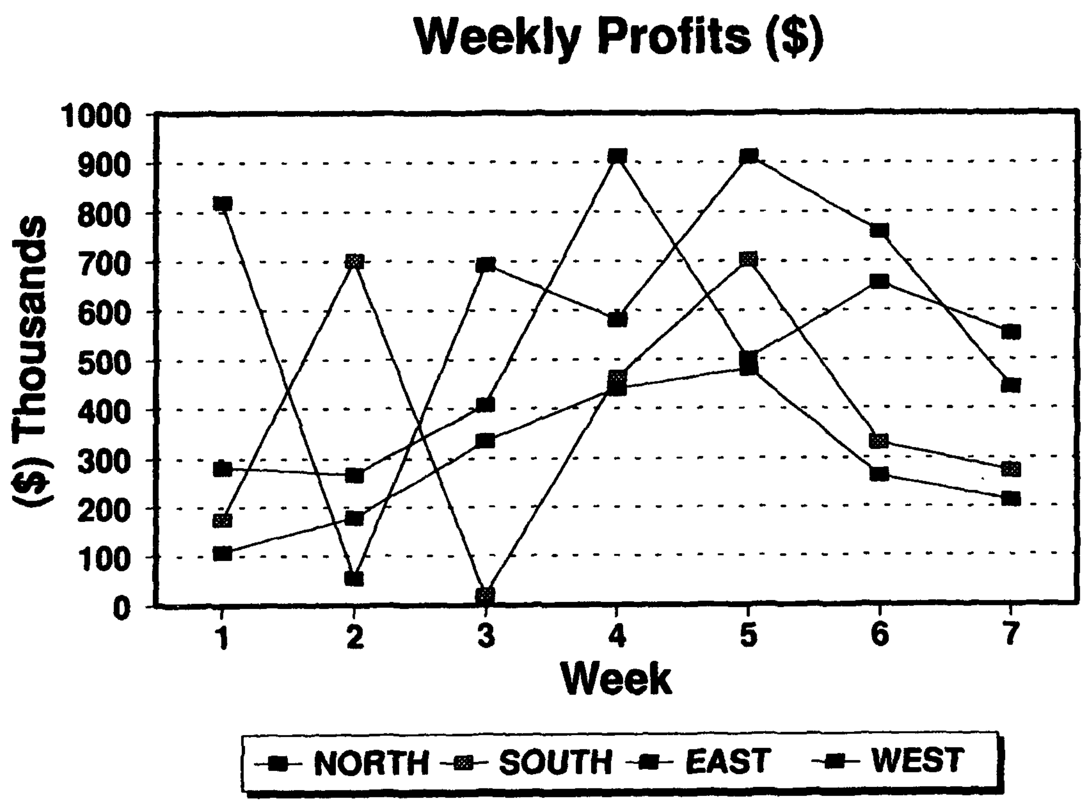


Which region had the highest cost in week 2?
(1) North (2) South (3) East (4) West

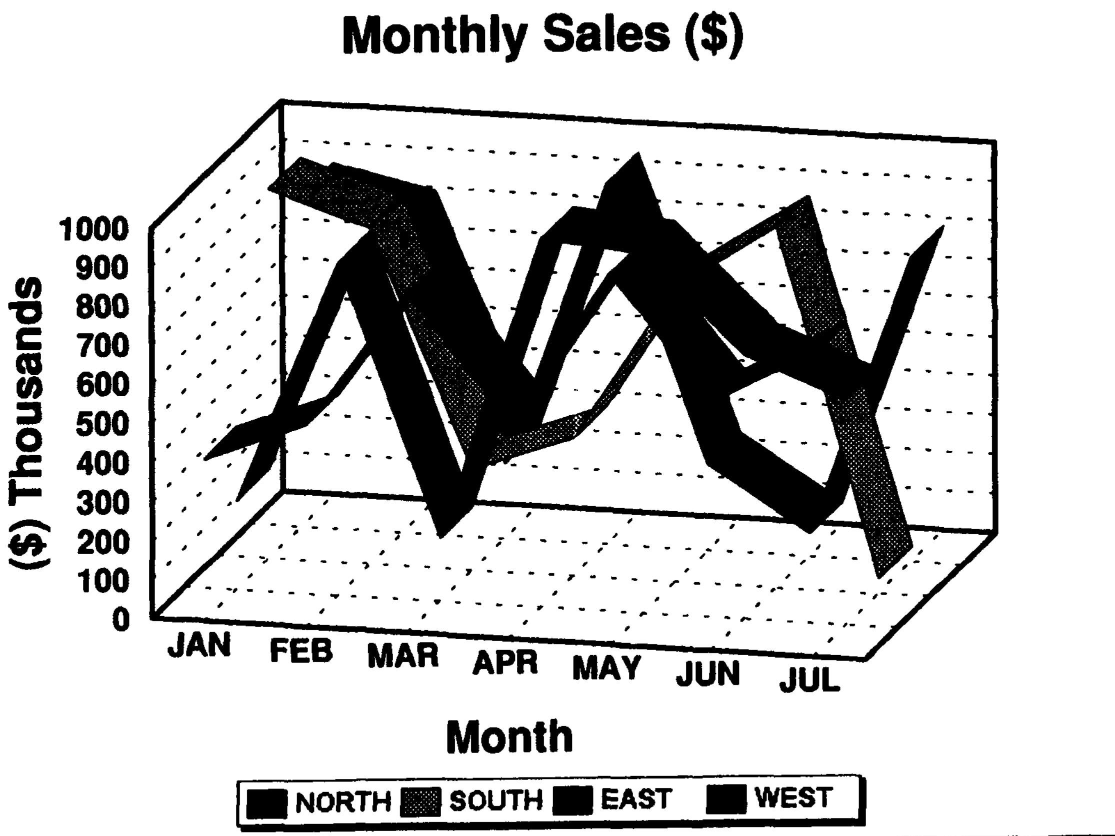
Monthly Costs ($)



Which region had the greatest decrease in costs from May to Jun?
(1) North (2) South (3) East (4) West



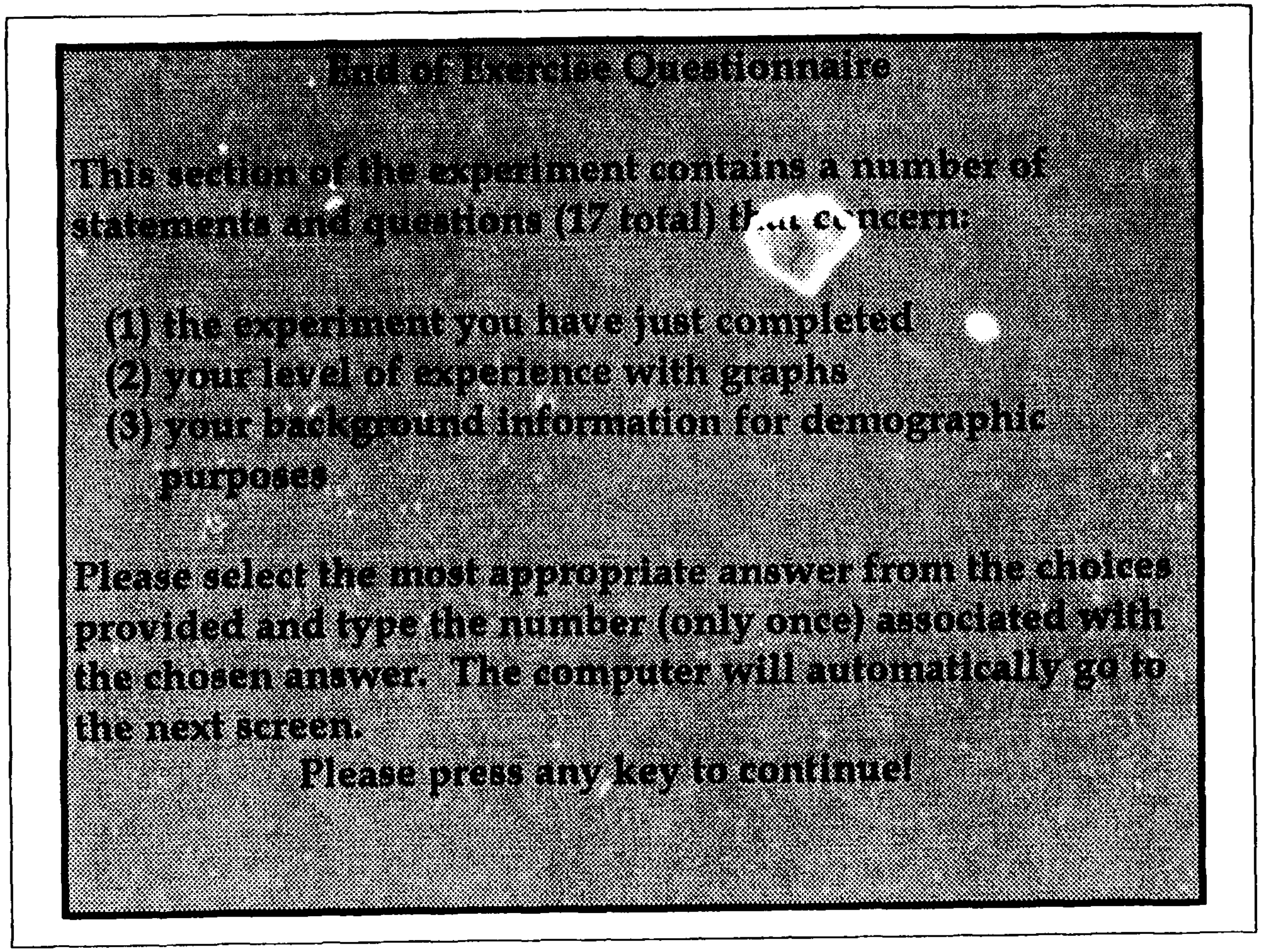
Which region had the greatest decrease in profits between weeks 5 & 6?
(1) North (2) South (3) East (4) West



Which region had the greatest sales increase from Mar to Apr?
(1) North (2) South (3) East (4) West

Appendix B. Experimental Item End-of-Exercise Questionnaire

This appendix contains the slides used to administer the end-of-exercise questionnaire. Like the experimental item these slides were displayed on the computer screen in color. The subjects' responses to these questions are provided in Table 30.


End of Exercise Questionnaire
This section of the experiment contains a number of statements and questions (17 total) that concern:
(1) the experiment you have just completed
(2) your level of experience with graphs
(3) your background information for demographic purposes
Please select the most appropriate answer from the choices provided and type the number (only once) associated with the chosen answer. The computer will automatically go to the next screen.
Please press any key to continue!

Question 1

The financial information was easy to understand?

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree
				Neither				

Question 2

Which charts (graphs and tables) were the most useful for identifying each regions financial information?

(1) Tables
(2) 2D Bar Charts
(3) 2D Line Charts
(4) 3D Bar Charts
(5) 3D Line Charts

Question 3

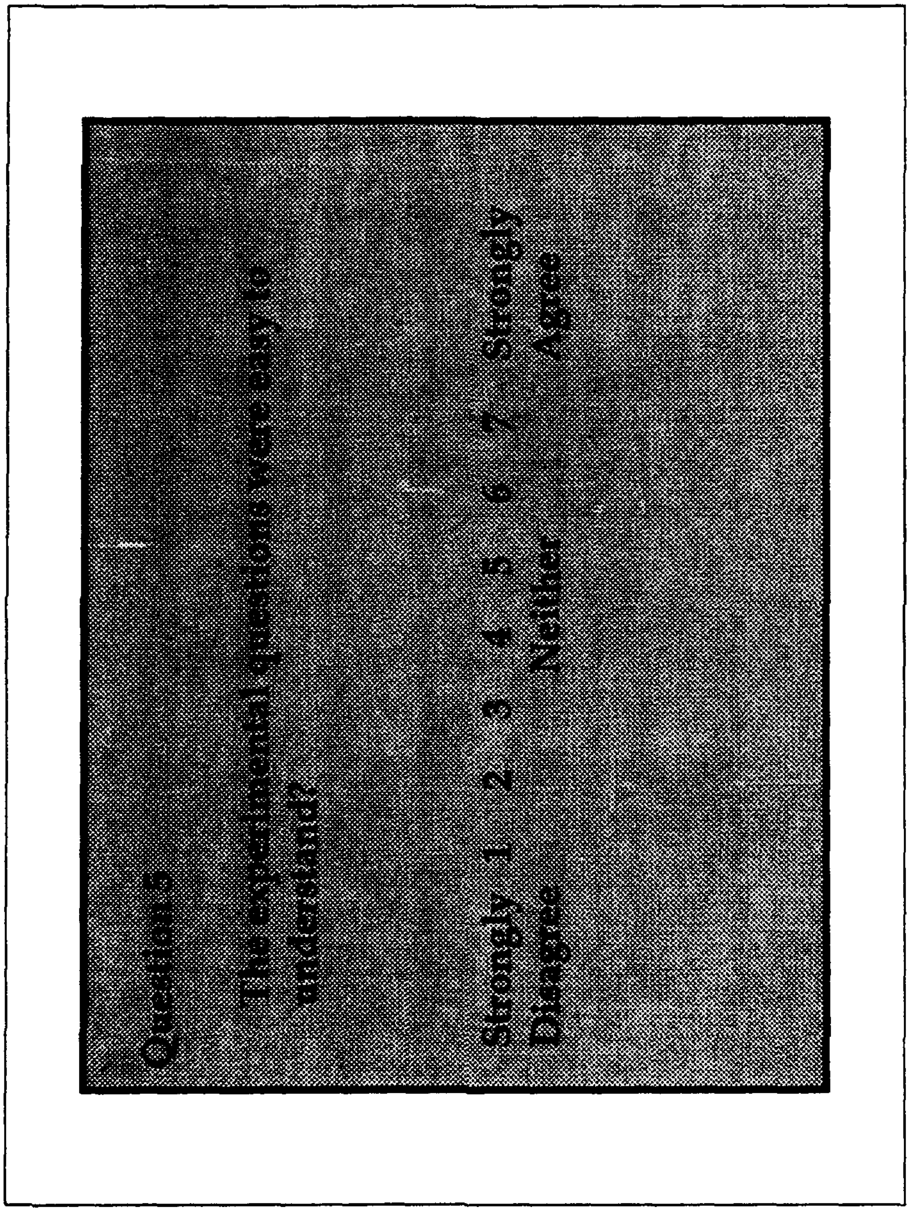
Which charts (graphs and tables) were the most useful for comparing regional information?

(1) Tables
(2) 2D Bar Charts
(3) 2D Line Charts
(4) 3D Bar Charts
(5) 3D Line Charts

Question 4

The charts (graphs and tables) contained too much information to adequately make a decision?

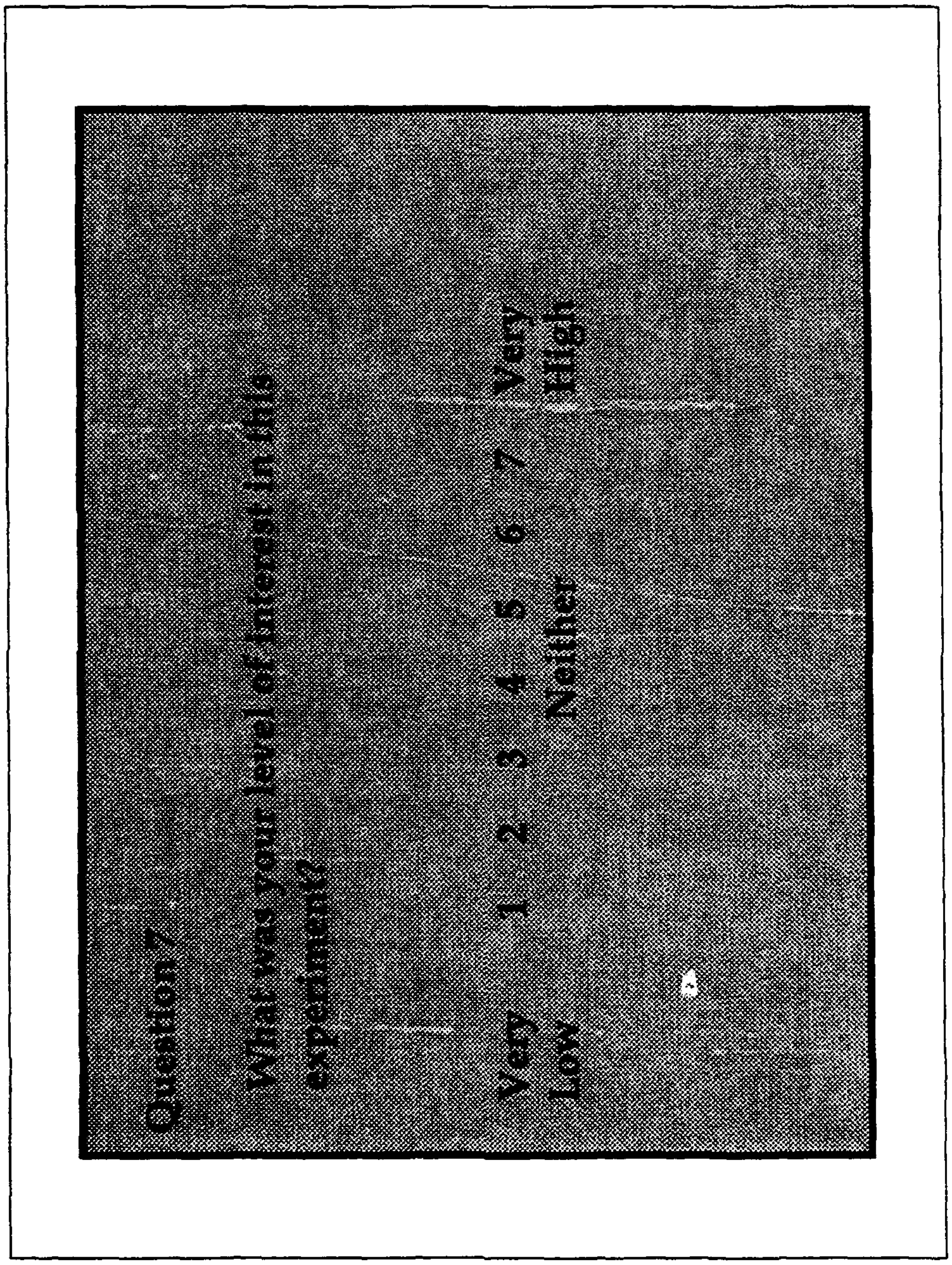
Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree
				Neither				

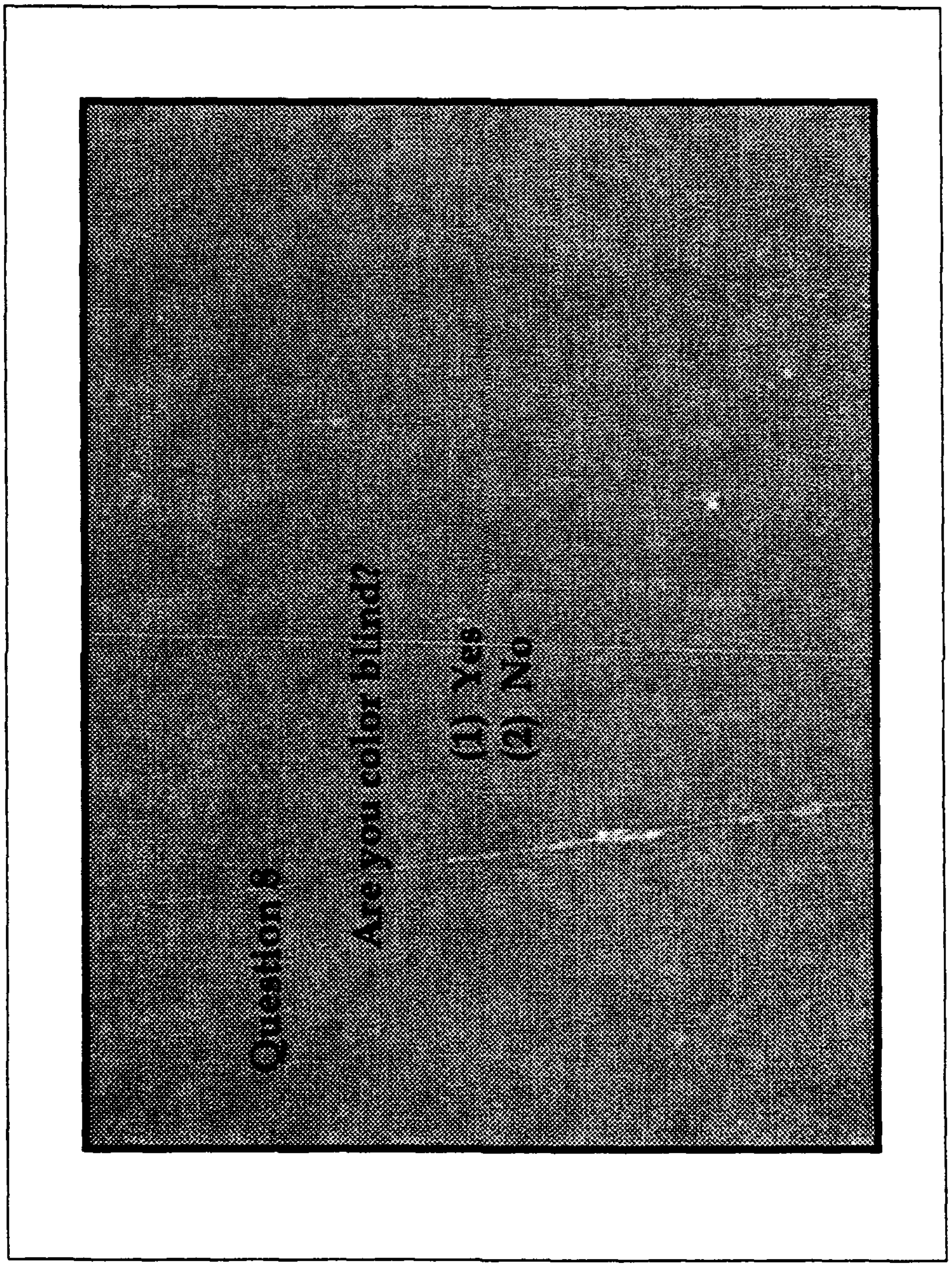

Question 5
The experimental questions were easy to understand?
Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree
Neither

Question 6

Which presentation format do you prefer for the presentation of information?

(1) Tables
(2) 2D Bar Charts
(3) 2D Line Charts
(4) 3D Bar Charts
(5) 3D Line Charts
(6) Other


Question 7
What was your level of interest in this experiment?
Very Low
1 2 3 4 5 6 7
Very High
Neither


Question 8
Are you color blind?
(1) Yes
(2) No

Question 9

How often do you construct graphs/ charts for presentations?

(1) Daily
(2) Every Other Day
(3) At Least Once a Week
(4) At Least Twice a Month
(5) At Least Once a Month
(6) At Least Once Every Few Months
(7) At Least Once a Year
(8) Never

Question 10

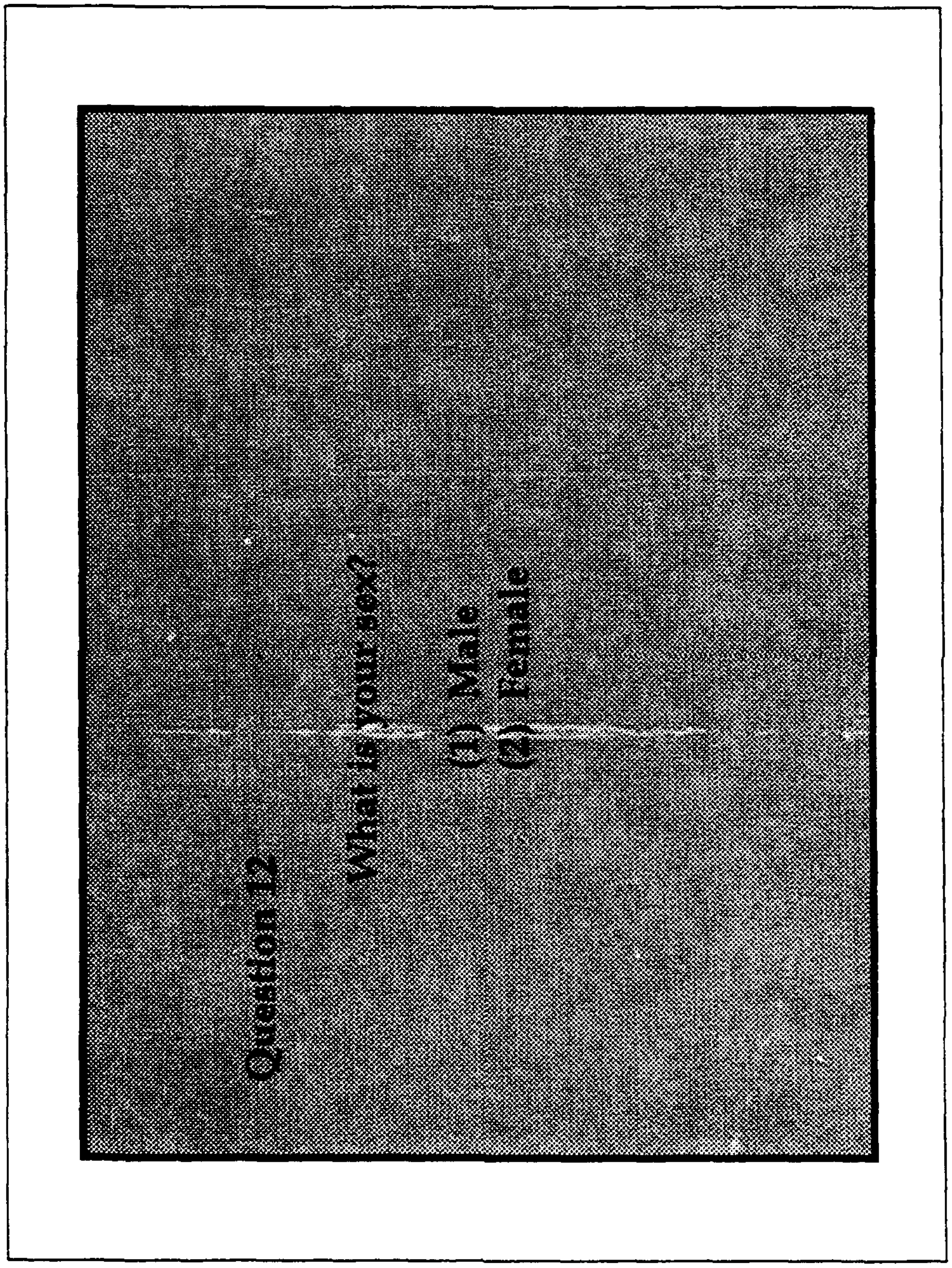
Have you ever had any formal training with graph construction or interpretation?

(1) Yes, formal training on graph construction
(2) Yes, formal training on graph interpretation
(3) Yes, formal training on both
(4) Yes, informal training on graph construction
(5) Yes, informal training on graph interpretation
(6) Yes, informal training on both
(7) No training in either

Question 11

How often do you use graphics in decision making?

(1) Daily
(2) Every Other Day
(3) At Least Once a Week
(4) At Least Twice a Month
(5) At Least Once a Month
(6) At Least Once Every Few Months
(7) At Least Once a Year
(8) Never


Question 12
What is your sex?
(1) Male
(2) Female

Question 13

What is your rank?

(1) GS-3 to GS-7
(2) GS-8 to GS-12
(3) GS/M-13 to GS/M-15
(4) SES
(5) E-1 to E-4
(6) E-5 to E-6
(7) E-7 to E-9
(8) O-1 to O-3
(9) O-4 and above

Question 14

What is your educational background?

(1) High School Graduate
(2) Some College
(3) Associate Degree
(4) Baccalaureate Degree
(5) Some Graduate Courses
(6) Master's Degree
(7) Doctoral Degree

Question 15

Which of the following areas do you consider to be the primary basis for your professional experience?

(1) Technical
(2) Scientific
(3) Engineering
(4) Operations
(5) Financial
(6) Managerial
(7) Contracts
(8) Other

Question 16

How many years of experience do you have in the professional area identified in the previous question?

(1) Less than 2
(2) 2 to 4
(3) 5 to 7
(4) 8 to 10
(5) 11 to 13
(6) 14 to 16
(7) 17 to 19
(8) 20 or more

Question 17

If you are employed by the USAF, to which Major Command are you assigned?

(1) Air Combat Command (ACC)
(2) Air Force Materiel Command (AFMC)
(3) Air Mobility Command (AMC)
(4) Air Education & Training Command (AETC)
(5) Pacific Air Forces (PACAF)
(6) United States Air Forces Europe (USAFE)
(7) Other
(8) Not Employed by the USAF

We'd like to thank you for your participation!

Please contact either Capt Tony Villanueva or Capt Anita Latin (the monitors) to inform them you have completed the experiment.

Appendix C. Experimental Item Macro Sheet

The purpose of this appendix is to provide and explain the macro sheet that was used to automate the experimental item. There are basically two parts of this appendix. Part 1 (Pages 178-188) is an example of the macro sheet which shows the current value of each cell. Since the macro sheet has 20 columns and 304 rows, it takes more than one page to print it out. The row and column headings are provided to facilitate the explanation and provide a reference for piecing the individual pages together. Part 2 (Pages 189-210) of this appendix is a very valuable reference item that provides the actual formulas that are in each cell of the macro sheet.

A macro sheet is structured like a spreadsheet. It is made up of cells organized in to rows and columns. Each row is identified by a number while each column is identified by a letter. For example the first row is Row 1, the second is Row 2, the third is Row 3, etc. The columns are label the same way starting with the letter A. A particular cell is identified by the column and row that it is in. For example, the cell in the upper left hand corner of a sheet is cell A1, because it is in Column A and Row 1. A block of cells are identified by the cell in the upper left hand corner and the cell in lower right hand corner of the block. For example, the block of cells containing (A1, A2, B1, & B2) has the following reference: A1..B2. A cell can contain text or numerical information entered directly, or it can contain a formula that is use to calculate the text or numerical value that appears in the cell.

A macro is simply a list of commands that the computers executes one after another when directed to. The macro used it this experiment starts in cell B1 and continues until cell B304. A macro is run by telling the computer to start at a given cell (B1 in this case) an execute each command it encounters until it is directed to quit. The computer performs this function by starting at the identified cell, executing the command contained in that cell, and then continues to the following cell in that column. If it does not encounter the quit command before it reaches the end of the column, the computer will continue at the top of

the next column. It will proceed in this manner until it encounters the quit command or reaches the end of the sheet.

A macro command is easily distinguished from other cell values because it is entirely contained in brackets: {macro command}. A cell can contain more than one command. Each command is enclosed in a separate set of brackets:

{macro command 1}{macro command 2}{macro command 3} etc.

The macro sheet used in this experiment has five distinct sections:

(1) A1..B304 is the macro,

(2) D1..N25 is use by the macro to randomize the order that charts are presented,

(3) E29..K56 is used to store the subjects response and response time,

(4) E150..O208 contains the data set used to create the graphs,

(5) The chart page which contains all of charts to be displayed.

The following discussion will start with an explanation of the chart page and the data section of the macro sheet (E150..O208), and then cover the other three sections of the macro sheet as they relate to each other.

In addition to being an excellent spread sheet application, Quatro Pro is designed to be a briefing tool. It gives the user the ability to create all the slides required to give a briefing and store them as part of the document they are working on. Briefing slides can contain charts generated from data contained in the spreadsheet, or normal text slides. The chart page is used to create briefing slides. After creating a slide it can be given a name and saved. A slide that has been saved shows up as an icon on the chart page. This capability was use to generate and save all of the slides required for the experiment. Appendix ?? contains all of the slides used in this experiment. The graphs in these slide were generated from the various data sets contained in E150..O208 of the macro sheet. Once the slides were created and saved to the chart page, macro commands could be used to display them at the appropriate time.

As stated previously the macro for the experiment is contained in cells B1..B304. The macro performs five basic tasks. First, it sets up a controlled operating environment for the experiment. It does this by disabling all of the menus and interrupt keys (break, esc, etc.). It also hides the macro sheet and turns off normal screen updating. Second, it randomizes the order in which charts are to be presented. Third, the macro presents the charts based on the randomized order, captures the subjects response and response time, and then stores the data in the response section (E29..K56). Fourth, the macro presents the end of exercise questionnaire slides and then captures and stores the subjects response. Finally, the macro restores the operating environment to its original state and writes the results of the experiment to a text file. The text files was used to consolidate the data and import the results in to various statistical applications.

To save time, the button "Main" was created so that the macro could be executed by simply clicking on the button with the mouse. Since cell references can be cumbersome, it often easier to give a cell a name, and then refer to that cell by using the name instead of using the column-row reference. Whenever a cell was given a name in the macro sheet, the name was provided in the cell immediately to its left. For example, cell B21 was given the name "Chart1". To document this fact the text "Chart1" was place in cell A21.

The following discussion of the macro will provide cell references and discuss what functions those cell are performing.

B1: Turns off normal screen updating.

B2..B10: Hides the menus.

B11: Disables interrupt keys.

B12..B16: These cell sort the cell block E1..L25 by rows based on the values contained in column E. Cells E1..E11 and E15..E25 contain a formula that generates a random number. When the block is sorted according the values in column E, the order of the rows are effectively randomized. The

information in these row will be used by the macro to present the charts. This ensures that the charts will be presented in a randomized. Cells E12..E14 contain the numbers 1,0,& -1 respectively. This ensures that the these three masking charts are always presented in the same order when the subjects are half-way through the experiment.

B17: Hides the macro sheet.

B18: Adds the menu defined in the cell range "menuid" (cell P4). It takes the computer a second or two to load and display the next slide in the presentation. During this time the subjects see the an empty window and the menu bar. This command places the word "Processing..." on the menu bar. The purpose is to simply add a nice effect while the subjects are waiting for the next slide.

B19: Displays the slide called "start" from the chart page. This slide provides the introduction to the experiment. When subjects arrive to take the experiment this slide is already on the screen. Thus, the macro has already completed the commands in cell B1..B19. When the macro displays a slide, it will not continue until a key is pushed. After the subjects read this slide they continue the experiment/macro by pressing any key.

B20..B26: These cells are responsible for presenting the first chart of the experiment, and capturing and recording the subjects response and response time. The commands required to perform these tasks are in the first row of the block E1..N25. Remember, columns E through L of this block were randomized earlier. This means that the order in which charts are presented is random. Cell B20..B26 are filled with formulas that reference the first row of the block E1..N25. For example, B20 has the

formula "+F1". This formula sets the value of B20 equal to the value of F1. Since F1 is contains the command "[LET I141,@NOW:VALUE}", this same command appears in cell B20. The macro then executes that command when it gets to B20.

B20: Captures the current time and places it in column of I of the response section. The row it is placed in corresponds to the chart that is being displayed. This command effectively captures when the chart is initially displayed.

B21: Contains the formula "+G1". The command in G1 displays one of the graphs. Due to the random sort this chart is the first to be displayed.

B22: Contains the formula "+H1". This command captures the key stroke the subject pushed to clear the chart and stores in the appropriate cell in column G of the response section. Each slide contained a question with four response. The subjects were instructed to press the number key (1,2,3, or 4) that corresponded to their answer to question. Upon pressing the key, the slide was cleared and the answer was recorded.

B23: Contains the formula "+I1". The command in I1 captures the current time and places it the appropriate cell in column J of the response section. This is the time when the subject has given a valid response to the slide. The column K of the response section contains a formula that subjects the time in column I from the time in column J. This is the subjects response time for the slide.

B24: Contains the formula "+L1". The command in L1 checks to see if the subjects response is a "~". If it is, the macro branches to the cell name "ShowMenu". The purpose of this is to allow the researchers to interrupt the experiment if necessary.

B25: Contains the formulas "+J1&M1&N1". This formula places the three commands in J1, M1, and N1 in to cell B25. These commands check to see if the subjects response is less the 1. If it is, the response is not valid. To remedy the situation the subjects are shown a warning message identified by cells P1..T2. The message reminds the subject that the response must be a number between 1 and 4. The macro then branches to the cell named "Chart1". This allows the chart currently being considered to be displayed again.

B26: Contains the formulas "+K1&M1&N1". This formula places the three commands in K1, M1, and N1 in to cell B26. These commands check to see if the subjects response is greater than 4. If it is, the response is not valid. To remedy the situation the subjects are shown a warning message identified by cells P1..T2. The message reminds the subject that the response must be a number between 1 and 4. The macro then branches to the cell named "Chart1". This allows the chart currently being considered to be displayed again.

B27..B194: These cells are similar in function to B20..B26. For example, B27..B34 displays the second chart with the commands from the second row of the randomization section. This pattern is repeated, until all of the experimental slides have been shown.

B195: Display the slide "Qstart". This slides informs the subjects that they have completed the experiment and that the end of exercise questionnaire is next.

B196..B280: The commands in these cell are similar to those used in B20..B194. The difference is that the cells do not contain references. Because the order of the questions for the end of exercise questionnaire is fixed so the cells can

contain the actual commands. The commands in these cells display the slides that contained the end of exercise questions and capture the subjects response. If the response is valid, it is recorded in survey response section, E57..F74. If not, the slide containing the question under current consideration is re-displayed.

B281..B282: Displays the final slide. If the next key stroke is not a "~" is re-display this same slide. This allows the researchers to exit the macro under controlled conditions.

B285..B296: Returns the operating environment to its initial state.

B297: Reserved line.

B298: Ensure the calculations in the response section are performed. Column F of the response section contains the correct answer to the question asked on each chart. Column G contains the response give by the subject. *Column H contains the formula that compares* the values of Columns F and G. If the values are the same, the formula returns a "1". If they are not, it returns a "0". Thus, a in "1" in Column H means the question was answered correctly. The other part of the response section is to calculate the response time. Column I contains the time when a graph is initially displayed. Column J contains the time when the subject answered the question for that chart. The response time in Column K is calculated by subtracting Column I from Column J.

B299: Contains the formula "+C297&@STRING(C298,0)&C299". This formula opens a new file on drive A. The file is given a name with the ".txt" extension. The last three characters of the name are the Julian date for the day the experiment was given. The fourth character from the end is an underscore. The characters at the beginning of the name identify the

disk that the experiment was run from (S1, S2, S3, etc.). This method of naming text file provided the researchers with the date and the disk the results were from. If there had been a problem, this information might would have helped in identifying the source.

B300..B302: Writes the results store in the response section to the newly created file.

B303: Closed the results text file.

B304: Ends the macro.

Finally, Dr. Dave Christensen maintains a disk copy of the experimental item. If you would like a copy, please contact him at AFIT/LAS Bldg 641, 2950 P St, Wright-Patterson AFB OH 45433-9905.

A	A	B	C
1	Main	{APPLICATION.DISPLAY "none,no,no,no,a..b:a1..b2"}	
2		{setobjectproperty "/File.hidden","yes"}	
3		{setobjectproperty "/EDIT.hidden","yes"}	
4		{setobjectproperty "/BLOCK.hidden","yes"}	
5		{setobjectproperty "/DATA.hidden","yes"}	
6		{setobjectproperty "/TOOLS.hidden","yes"}	
7		{setobjectproperty "/GRAPH.hidden","yes"}	
8		{setobjectproperty "/PROPERTY.hidden","yes"}	
9		{setobjectproperty "/WINDOW.hidden","yes"}	
10		{setobjectproperty "/HELP.hidden","yes"}	
11		{breakoff}	
12	Sort	{sort.reset}	
13		{sort.block e1..l25}	
14		{sort.key_1 e1}	
15		{sort.order_1 ascending}	
16		{sort.go}	
17		{Windowhide}	
18		{addmenu /file, menuid}	
19		{graphview start}	
20		{LET I35,@NOW:VALUE}	
21	Chart1	{graphview b2hh}	
22		{GRAPHCHAR G35}	
23		{LET J35,@NOW:VALUE}	
24		{if @@("G35")="~"}{Branch ShowMenu}	
25		{if @@("G35")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart1}	
26		{if @@("G35")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart1}	
27		{LET I37,@NOW:VALUE}	
28	Chart2	{graphview b2lh}	
29		{GRAPHCHAR G37}	
30		{LET J37,@NOW:VALUE}	
31		{if @@("G37")="~"}{Branch ShowMenu}	
32		{if @@("G37")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart2}	
33		{if @@("G37")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart2}	
34		{LET I40,@NOW:VALUE}	
35	Chart3	{graphview b3hl}	
36		{GRAPHCHAR G40}	
37		{LET J40,@NOW:VALUE}	
38		{if @@("G40")="~"}{Branch ShowMenu}	
39		{if @@("G40")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart3}	
40		{if @@("G40")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart3}	
41		{LET I42,@NOW:VALUE}	
42	Chart4	{graphview b3ll}	
43		{GRAPHCHAR G42}	
44		{LET J42,@NOW:VALUE}	
45		{if @@("G42")="~"}{Branch ShowMenu}	
46		{if @@("G42")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart4}	
47		{if @@("G42")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart4}	
48		{LET I43,@NOW:VALUE}	
49	Chart5	{graphview l2hh}	
50		{GRAPHCHAR G43}	
51		{LET J43,@NOW:VALUE}	
52		{if @@("G43")="~"}{Branch ShowMenu}	
53		{if @@("G43")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart5}	
54		{if @@("G43")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart5}	

A	A	B	C
55		{LET I45,@NOW:VALUE}	
56	Chart6	{graphview 12lh}	
57		{GRAPHCHAR G45}	
58		{LET J45,@NOW:VALUE}	
59		{if @@("G45")="~"}{Branch ShowMenu}	
60		{if @@("G45")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart6}	
61		{if @@("G45")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart6}	
62		{LET I48,@NOW:VALUE}	
63	Chart7	{graphview 13hl}	
64		{GRAPHCHAR G48}	
65		{LET J48,@NOW:VALUE}	
66		{if @@("G48")="~"}{Branch ShowMenu}	
67		{if @@("G48")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart7}	
68		{if @@("G48")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart7}	
69		{LET I50,@NOW:VALUE}	
70	Chart8	{graphview 13ll}	
71		{GRAPHCHAR G50}	
72		{LET J50,@NOW:VALUE}	
73		{if @@("G50")="~"}{Branch ShowMenu}	
74		{if @@("G50")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart8}	
75		{if @@("G50")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart8}	
76		{LET I52,@NOW:VALUE}	
77	Chart9	{graphview mb2}	
78		{GRAPHCHAR G52}	
79		{LET J52,@NOW:VALUE}	
80		{if @@("G52")="~"}{Branch ShowMenu}	
81		{if @@("G52")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart9}	
82		{if @@("G52")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart9}	
83		{LET I31,@NOW:VALUE}	
84	Chart10	{graphview thh}	
85		{GRAPHCHAR G31}	
86		{LET J31,@NOW:VALUE}	
87		{if @@("G31")="~"}{Branch ShowMenu}	
88		{if @@("G31")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart10}	
89		{if @@("G31")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart10}	
90		{LET I33,@NOW:VALUE}	
91	Chart11	{graphview tlh}	
92		{GRAPHCHAR G33}	
93		{LET J33,@NOW:VALUE}	
94		{if @@("G33")="~"}{Branch ShowMenu}	
95		{if @@("G33")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart11}	
96		{if @@("G33")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart11}	
97		{LET I54,@NOW:VALUE}	
98	Chart12	{graphview ml2}	
99		{GRAPHCHAR G54}	
100		{LET J54,@NOW:VALUE}	
101		{if @@("G54")="~"}{Branch ShowMenu}	
102		{if @@("G54")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart12}	
103		{if @@("G54")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart12}	
104		{LET I51,@NOW:VALUE}	
105	Chart13	{graphview mt}	
106		{GRAPHCHAR G51}	
107		{LET J51,@NOW:VALUE}	
108		{if @@("G51")="~"}{Branch ShowMenu}	
109		{if @@("G51")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart13}	

A	A	B	C
110		{if @@("G51")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart13}	
111		{LET I55,@NOW:VALUE}	
112	Chart14	{graphview ml3}	
113		{GRAPHCHAR G55}	
114		{LET J55,@NOW:VALUE}	
115		{if @@("G55")="~"}{Branch ShowMenu}	
116		{if @@("G55")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart14}	
117		{if @@("G55")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart14}	
118		{LET I36,@NOW:VALUE}	
119	Chart15	{graphview b2hl}	
120		{GRAPHCHAR G36}	
121		{LET J36,@NOW:VALUE}	
122		{if @@("G36")="~"}{Branch ShowMenu}	
123		{if @@("G36")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart15}	
124		{if @@("G36")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart15}	
125		{LET I38,@NOW:VALUE}	
126	Chart16	{graphview b2ll}	
127		{GRAPHCHAR G38}	
128		{LET J38,@NOW:VALUE}	
129		{if @@("G38")="~"}{Branch ShowMenu}	
130		{if @@("G38")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart16}	
131		{if @@("G38")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart16}	
132		{LET I39,@NOW:VALUE}	
133	Chart17	{graphview b3hh}	
134		{GRAPHCHAR G39}	
135		{LET J39,@NOW:VALUE}	
136		{if @@("G39")="~"}{Branch ShowMenu}	
137		{if @@("G39")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart17}	
138		{if @@("G39")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart17}	
139		{LET I41,@NOW:VALUE}	
140	Chart18	{graphview b3lh}	
141		{GRAPHCHAR G41}	
142		{LET J41,@NOW:VALUE}	
143		{if @@("G41")="~"}{Branch ShowMenu}	
144		{if @@("G41")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart18}	
145		{if @@("G41")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart18}	
146		{LET I44,@NOW:VALUE}	
147	Chart19	{graphview l2hl}	
148		{GRAPHCHAR G44}	
149		{LET J44,@NOW:VALUE}	
150		{if @@("G44")="~"}{Branch ShowMenu}	
151		{if @@("G44")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart19}	
152		{if @@("G44")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart19}	
153		{LET I46,@NOW:VALUE}	
154	Chart20	{graphview l2ll}	
155		{GRAPHCHAR G46}	
156		{LET J46,@NOW:VALUE}	
157		{if @@("G46")="~"}{Branch ShowMenu}	
158		{if @@("G46")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart20}	
159		{if @@("G46")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart20}	
160		{LET I47,@NOW:VALUE}	
161	Chart21	{graphview l3hh}	
162		{GRAPHCHAR G47}	
163		{LET J47,@NOW:VALUE}	
164		{if @@("G47")="~"}{Branch ShowMenu}	

A	A	B	C
165		{if @@("G47")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart21}	
166		{if @@("G47")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart21}	
167		{LET I49,@NOW:VALUE}	
168	Chart22	{graphview l3lh}	
169		{GRAPHCHAR G49}	
170		{LET J49,@NOW:VALUE}	
171		{if @@("G49")="~"}{Branch ShowMenu}	
172		{if @@("G49")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart22}	
173		{if @@("G49")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart22}	
174		{LET I53,@NOW:VALUE}	
175	Chart23	{graphview mb3}	
176		{GRAPHCHAR G53}	
177		{LET J53,@NOW:VALUE}	
178		{if @@("G53")="~"}{Branch ShowMenu}	
179		{if @@("G53")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart23}	
180		{if @@("G53")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart23}	
181		{LET I32,@NOW:VALUE}	
182	Chart24	{graphview thl}	
183		{GRAPHCHAR G32}	
184		{LET J32,@NOW:VALUE}	
185		{if @@("G32")="~"}{Branch ShowMenu}	
186		{if @@("G32")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart24}	
187		{if @@("G32")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart24}	
188		{LET I34,@NOW:VALUE}	
189	Chart25	{graphview tll}	
190		{GRAPHCHAR G34}	
191		{LET J34,@NOW:VALUE}	
192		{if @@("G34")="~"}{Branch ShowMenu}	
193		{if @@("G34")<"1"}{BEEP}{Message Msg,28,13,0}{Branch Chart25}	
194		{if @@("G34")>"4"}{BEEP}{Message Msg,28,13,0}{Branch Chart25}	
195		{GRAPHVIEW Qstart}	
196	Question1	{GRAPHVIEW Q1}	
197		{GRAPHCHAR F58}	
198		{if @@("F58")="~"}{Branch ShowMenu}	
199		{if @@("F58")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question1}	
200		{if @@("F58")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question1}	
201	Question2	{GRAPHVIEW Q2}	
202		{GRAPHCHAR F59}	
203		{if @@("F59")="~"}{Branch ShowMenu}	
204		{if @@("F59")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question2}	
205		{if @@("F59")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question2}	
206	Question3	{GRAPHVIEW Q3}	
207		{GRAPHCHAR F60}	
208		{if @@("F60")="~"}{Branch ShowMenu}	
209		{if @@("F60")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question3}	
210		{if @@("F60")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question3}	
211	Question4	{GRAPHVIEW Q4}	
212		{GRAPHCHAR F61}	
213		{if @@("F61")="~"}{Branch ShowMenu}	
214		{if @@("F61")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question4}	
215		{if @@("F61")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question4}	
216	Question5	{GRAPHVIEW Q5}	
217		{GRAPHCHAR F62}	
218		{if @@("F62")="~"}{Branch ShowMenu}	
219		{if @@("F62")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question5}	

A	A	B	C
220		{if @@("F62")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question5}	
221	Question6	{GRAPHVIEW Q6}	
222		{GRAPHCHAR F63}	
223		{if @@("F63")="~"}{Branch ShowMenu}	
224		{if @@("F63")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question6}	
225		{if @@("F63")>"6"}{BEEP}{Message Msg2,28,13,0}{Branch Question6}	
226	Question7	{GRAPHVIEW Q7}	
227		{GRAPHCHAR F64}	
228		{if @@("F64")="~"}{Branch ShowMenu}	
229		{if @@("F64")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question7}	
230		{if @@("F64")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question7}	
231	Question8	{GRAPHVIEW Q8}	
232		{GRAPHCHAR F65}	
233		{if @@("F65")="~"}{Branch ShowMenu}	
234		{if @@("F65")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question8}	
235		{if @@("F65")>"2"}{BEEP}{Message Msg2,28,13,0}{Branch Question8}	
236	Question9	{GRAPHVIEW Q9}	
237		{GRAPHCHAR F66}	
238		{if @@("F66")="~"}{Branch ShowMenu}	
239		{if @@("F66")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question9}	
240		{if @@("F66")>"8"}{BEEP}{Message Msg2,28,13,0}{Branch Question9}	
241	Question10	{GRAPHVIEW Q10}	
242		{GRAPHCHAR F67}	
243		{if @@("F67")="~"}{Branch ShowMenu}	
244		{if @@("F67")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question10}	
245		{if @@("F67")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question10}	
246	Question11	{GRAPHVIEW Q11}	
247		{GRAPHCHAR F68}	
248		{if @@("F68")="~"}{Branch ShowMenu}	
249		{if @@("F68")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question11}	
250		{if @@("F68")>"8"}{BEEP}{Message Msg2,28,13,0}{Branch Question11}	
251	Question12	{GRAPHVIEW Q12}	
252		{GRAPHCHAR F69}	
253		{if @@("F69")="~"}{Branch ShowMenu}	
254		{if @@("F69")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question12}	
255		{if @@("F69")>"2"}{BEEP}{Message Msg2,28,13,0}{Branch Question12}	
256	Question13	{GRAPHVIEW Q13}	
257		{GRAPHCHAR F70}	
258		{if @@("F70")="~"}{Branch ShowMenu}	
259		{if @@("F70")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question13}	
260		{if @@("F70")>"9"}{BEEP}{Message Msg2,28,13,0}{Branch Question13}	
261	Question14	{GRAPHVIEW Q14}	
262		{GRAPHCHAR F71}	
263		{if @@("F71")="~"}{Branch ShowMenu}	
264		{if @@("F71")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question14}	
265		{if @@("F71")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question14}	
266	Question15	{GRAPHVIEW Q15}	
267		{GRAPHCHAR F72}	
268		{if @@("F72")="~"}{Branch ShowMenu}	
269		{if @@("F72")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question15}	
270		{if @@("F72")>"8"}{BEEP}{Message Msg2,28,13,0}{Branch Question15}	
271	Question16	{GRAPHVIEW Q16}	
272		{GRAPHCHAR F73}	
273		{if @@("F73")="~"}{Branch ShowMenu}	
274		{if @@("F73")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question16}	

A	A	B	C
275		{if @@("F73")>"8"}{BEEP}{Message Msg2,28,13,0}{Branch Question16}	
276	Question17	{GRAPHVIEW Q17}	
277		{GRAPHCHAR F74}	
278		{if @@("F74")="~"}{Branch ShowMenu}	
279		{if @@("F74")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question17}	
280		{if @@("F74")>"8"}{BEEP}{Message Msg2,28,13,0}{Branch Question17}	
281	TheEnd	{GRAPHVIEW THE_END}	
282	~	{GRAPHCHAR A282}	
283		{if @@("A282")<>"~"}{Branch TheEnd}	
284	ShowMenu	{deletemenu /Processing ...}	
285		{Breakon}	
286		{APPLICATION.DISPLAY "none,yes,yes,yes,a..b:a1..b2"}	
287		{setobjectproperty "/File.hidden","no"}	
288		{setobjectproperty "/EDIT.hidden","no"}	
289		{setobjectproperty "/BLOCK.hidden","no"}	
290		{setobjectproperty "/DATA.hidden","no"}	
291		{setobjectproperty "/TOOLS.hidden","no"}	
292		{setobjectproperty "/GRAPH.hidden","no"}	
293		{setobjectproperty "/PROPERTY.hidden","no"}	
294		{setobjectproperty "/WINDOW.hidden","no"}	
295		{setobjectproperty "/HELP.hidden","no"}	
296		{WINDOWshow thesis.wb1}	
297		{}	{OPEN "A:\S1_
298		{CALC}	217.00
299		{OPEN "A:\S1_217.txt",w}	.txt",w}
300		{Writeln "Cor_Ans,",+h31,",",+h32,",",+h33,",",+h34,",",+h35,",",+h36,",",+	
301		{writeln "Time,",@string(k31,0),",",@string(k32,0),",",@string(k33,0),",",@	
302		{Writeln "Survey,",+f58,",",+f59,",",+f60,",",+f61,",",+f62,",",+f63,",",+f64,	
303		{Close}	
304		{Quit}	

A	D	E	F	G	H	I	J
1	0.55	517.00	{LET I35,@NOW:VALUE}	{graphview b2hh}	{GRAPHCHAR G35}	{LET J35,@NOW:VALUE}	{if @@("G35")<"1"}
2	0.76	460.00	{LET I37,@NOW:VALUE}	{graphview b2lh}	{GRAPHCHAR G37}	{LET J37,@NOW:VALUE}	{if @@("G37")<"1"}
3	0.19	-211.00	{LET I40,@NOW:VALUE}	{graphview b3hl}	{GRAPHCHAR G40}	{LET J40,@NOW:VALUE}	{if @@("G40")<"1"}
4	0.31	-677.00	{LET I42,@NOW:VALUE}	{graphview b3ll}	{GRAPHCHAR G42}	{LET J42,@NOW:VALUE}	{if @@("G42")<"1"}
5	0.31	-934.00	{LET I43,@NOW:VALUE}	{graphview l2hh}	{GRAPHCHAR G43}	{LET J43,@NOW:VALUE}	{if @@("G43")<"1"}
6	0.29	-187.00	{LET I45,@NOW:VALUE}	{graphview l2lh}	{GRAPHCHAR G45}	{LET J45,@NOW:VALUE}	{if @@("G45")<"1"}
7	0.22	-83.00	{LET I48,@NOW:VALUE}	{graphview l3hl}	{GRAPHCHAR G48}	{LET J48,@NOW:VALUE}	{if @@("G48")<"1"}
8	0.55	204.00	{LET I50,@NOW:VALUE}	{graphview l3ll}	{GRAPHCHAR G50}	{LET J50,@NOW:VALUE}	{if @@("G50")<"1"}
9	0.52	288.00	{LET I52,@NOW:VALUE}	{graphview mb2}	{GRAPHCHAR G52}	{LET J52,@NOW:VALUE}	{if @@("G52")<"1"}
10	0.32	-494.00	{LET I31,@NOW:VALUE}	{graphview thh}	{GRAPHCHAR G31}	{LET J31,@NOW:VALUE}	{if @@("G31")<"1"}
11	0.99	789.00	{LET I33,@NOW:VALUE}	{graphview tlh}	{GRAPHCHAR G33}	{LET J33,@NOW:VALUE}	{if @@("G33")<"1"}
12		-1.00	{LET I54,@NOW:VALUE}	{graphview ml2}	{GRAPHCHAR G54}	{LET J54,@NOW:VALUE}	{if @@("G54")<"1"}
13		0.00	{LET I51,@NOW:VALUE}	{graphview mt}	{GRAPHCHAR G51}	{LET J51,@NOW:VALUE}	{if @@("G51")<"1"}
14		1.00	{LET I55,@NOW:VALUE}	{graphview ml3}	{GRAPHCHAR G55}	{LET J55,@NOW:VALUE}	{if @@("G55")<"1"}
15		242.00	{LET I36,@NOW:VALUE}	{graphview b2hl}	{GRAPHCHAR G36}	{LET J36,@NOW:VALUE}	{if @@("G36")<"1"}
16		-812.00	{LET I38,@NOW:VALUE}	{graphview b2ll}	{GRAPHCHAR G38}	{LET J38,@NOW:VALUE}	{if @@("G38")<"1"}
17		930.00	{LET I39,@NOW:VALUE}	{graphview b3hh}	{GRAPHCHAR G39}	{LET J39,@NOW:VALUE}	{if @@("G39")<"1"}
18		940.00	{LET I41,@NOW:VALUE}	{graphview b3lh}	{GRAPHCHAR G41}	{LET J41,@NOW:VALUE}	{if @@("G41")<"1"}
19		213.00	{LET I44,@NOW:VALUE}	{graphview l2hl}	{GRAPHCHAR G44}	{LET J44,@NOW:VALUE}	{if @@("G44")<"1"}
20		492.00	{LET I46,@NOW:VALUE}	{graphview l2ll}	{GRAPHCHAR G46}	{LET J46,@NOW:VALUE}	{if @@("G46")<"1"}
21		-791.00	{LET I47,@NOW:VALUE}	{graphview l3hh}	{GRAPHCHAR G47}	{LET J47,@NOW:VALUE}	{if @@("G47")<"1"}
22		-895.00	{LET I49,@NOW:VALUE}	{graphview l3lh}	{GRAPHCHAR G49}	{LET J49,@NOW:VALUE}	{if @@("G49")<"1"}
23		-288.00	{LET I53,@NOW:VALUE}	{graphview mb3}	{GRAPHCHAR G53}	{LET J53,@NOW:VALUE}	{if @@("G53")<"1"}
24		61.00	{LET I32,@NOW:VALUE}	{graphview thl}	{GRAPHCHAR G32}	{LET J32,@NOW:VALUE}	{if @@("G32")<"1"}
25		-123.00	{LET I34,@NOW:VALUE}	{graphview tll}	{GRAPHCHAR G34}	{LET J34,@NOW:VALUE}	{if @@("G34")<"1"}

A	K	L	M	N
1	{if @@("G35")>"4"}	{if @@("G35")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart1}
2	{if @@("G37")>"4"}	{if @@("G37")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart2}
3	{if @@("G40")>"4"}	{if @@("G40")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart3}
4	{if @@("G42")>"4"}	{if @@("G42")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart4}
5	{if @@("G43")>"4"}	{if @@("G43")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart5}
6	{if @@("G45")>"4"}	{if @@("G45")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart6}
7	{if @@("G48")>"4"}	{if @@("G48")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart7}
8	{if @@("G50")>"4"}	{if @@("G50")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart8}
9	{if @@("G52")>"4"}	{if @@("G52")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart9}
10	{if @@("G31")>"4"}	{if @@("G31")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart10}
11	{if @@("G33")>"4"}	{if @@("G33")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart11}
12	{if @@("G54")>"4"}	{if @@("G54")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart12}
13	{if @@("G51")>"4"}	{if @@("G51")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart13}
14	{if @@("G55")>"4"}	{if @@("G55")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart14}
15	{if @@("G36")>"4"}	{if @@("G36")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart15}
16	{if @@("G38")>"4"}	{if @@("G38")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart16}
17	{if @@("G39")>"4"}	{if @@("G39")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart17}
18	{if @@("G41")>"4"}	{if @@("G41")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart18}
19	{if @@("G44")>"4"}	{if @@("G44")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart19}
20	{if @@("G46")>"4"}	{if @@("G46")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart20}
21	{if @@("G47")>"4"}	{if @@("G47")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart21}
22	{if @@("G49")>"4"}	{if @@("G49")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart22}
23	{if @@("G53")>"4"}	{if @@("G53")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart23}
24	{if @@("G32")>"4"}	{if @@("G32")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart24}
25	{if @@("G34")>"4"}	{if @@("G34")="~"}{Branch ShowMenu}	{BEEP}{Message Msg,28,13,0}	{Branch Chart25}

A	E	F	G	H	I	J	K
29	RESPONSE SECTION						
30	NAME	KNOWN	OBSRVD	CORCT	TIME ST	TIME END	RESP TIME
31	THH	1	3	0	34438.387720	34438.387789	6.00
32	THL	4	1	0	34438.386354	34438.386412	5.00
33	TLH	3	2	0	34438.387326	34438.387396	6.00
34	TLL	2	4	0	34438.388044	34438.388090	4.00
35	B2HH	1	3	0	34438.387789	34438.387847	5.00
36	B2HL	4	1	0	34438.387963	34438.388044	7.00
37	B2LH	3	2	0	34438.386238	34438.386354	10.00
38	B2LL	2	4	0	34438.386713	34438.386771	5.00
39	B3HH	3	3	1	34438.388090	34438.388183	8.00
40	B3HL	1	1	1	34438.388275	34438.388403	11.00
41	B3LH	2	2	1	34438.387188	34438.387257	6.00
42	B3LL	4	3	0	34438.386840	34438.386956	10.00
43	L2HH	3	3	1	34438.388183	34438.388275	8.00
44	L2HL	1	2	0	34438.387523	34438.387604	7.00
45	L2LH	2	2	1	34438.387662	34438.387720	5.00
46	L2LL	4	4	1	34438.386956	34438.387083	11.00
47	L3HH	1	3	0	34438.386424	34438.386563	12.00
48	L3HL	4	3	0	34438.386563	34438.386713	13.00
49	L3LH	3	2	0	34438.387859	34438.387963	9.00
50	L3LL	2	2	1	34438.386771	34438.386829	5.00
51	MT	4	4	1	34438.387396	34438.387454	5.00
52	MB2	2	2	1	34438.387604	34438.387662	5.00
53	MB3	1	4	0	34438.387083	34438.387188	9.00
54	ML2	2	2	1	34438.387257	34438.387326	6.00
55	ML3	3	3	1	34438.387454	34438.387523	6.00
56					34438.39	34438.39	176.00

A	E	F	G	H	I	J	K	L	M	N	O
150	DATA SET 11						MT, MB2				
151		NORTH	SOUTH	EAST	WEST			NORTH	SOUTH	EAST	WEST
152	1987	371.00	596.00	679.00	905.00		1	516.00	156.00	224.00	79.00
153	1988	399.00	432.00	749.00	692.00		2	131.00	880.00	460.00	873.00
154	1989	531.00	379.00	632.00	700.00		3	800.00	241.00	329.00	975.00
155	1990	442.00	343.00	556.00	648.00		4	527.00	469.00	413.00	262.00
156	1991	507.00	398.00	620.00	540.00		5	253.00	870.00	133.00	506.00
157	1992	691.00	556.00	730.00	489.00		6	399.00	518.00	877.00	275.00
158	1993	589.00	353.00	858.00	759.00		7	98.00	528.00	252.00	267.00
159											
160	DATA SET 12						MB3				
161		NORTH	SOUTH	EAST	WEST			NORTH	SOUTH	EAST	WEST
162	JAN	71.00	296.00	379.00	605.00		JAN	874.00	810.00	793.00	474.00
163	FEB	99.00	132.00	449.00	392.00		FEB	740.00	573.00	895.00	783.00
164	MAR	231.00	79.00	332.00	400.00		MAR	169.00	786.00	504.00	920.00
165	APR	142.00	43.00	256.00	348.00		APR	268.00	167.00	332.00	466.00
166	MAY	207.00	98.00	320.00	240.00		MAY	500.00	181.00	359.00	483.00
167	JUN	391.00	256.00	430.00	189.00		JUN	89.00	895.00	661.00	250.00
168	JUL	289.00	53.00	558.00	459.00		JUL	279.00	190.00	151.00	942.00
169											
170	DATA SET 13						ML2				
171		NORTH	SOUTH	EAST	WEST			NORTH	SOUTH	EAST	WEST
172	1980	94	394	504	805		1	282.00	176.00	819.00	108.00
173	1981	132	176	597	521		2	267.00	701.00	56.00	179.00
174	1982	307	105	442	532		3	407.00	20.00	692.00	333.00
175	1983	189	57	340	463		4	913.00	463.00	580.00	440.00
176	1984	275	130	426	319		5	501.00	702.00	911.00	481.00
177	1985	520	340	572	251		6	655.00	330.00	759.00	264.00
178	1986	384	70	742	610		7	553.00	274.00	443.00	213.00
179											
180	DATA SET 14						ML3				
181		NORTH	SOUTH	EAST	WEST			NORTH	SOUTH	EAST	WEST
182	JUN	24	98	126	201		JAN	848.00	943.00	227.00	413.00
183	JUL	33	44	149	130		FEB	790.00	859.00	849.00	516.00
184	AUG	77	26	110	133		MAR	190.00	257.00	162.00	869.00
185	SEP	47	14	85	116		APR	920.00	351.00	942.00	555.00
186	OCT	69	33	106	80		MAY	217.00	752.00	922.00	949.00
187	NOV	130	85	143	63		JUN	57.00	923.00	675.00	636.00
188	DEC	96	18	186	153		JUL	778.00	38.00	575.00	775.00
189											
190	DATA SET 21						DATA SET 23				
191		NORTH	SOUTH	EAST	WEST			NORTH	SOUTH	EAST	WEST
192	1987	885.00	945.00	583.00	430.00		1980	778	858	376	173
193	1988	805.00	695.00	553.70	559.00		1981	672	525	337	344
194	1989	619.00	463.05	519.00	726.70		1982	424	217	291	568
195	1990	563.75	324.14	503.87	826.00		1983	351	32	271	700
196	1991	732.87	421.38	352.71	661.30		1984	576	161	70	481
197	1992	513.01	547.79	458.52	759.00		1985	283	330	211	610
198	1993	666.91	637.00	584.00	905.00		1986	488	448	378	805

A	E	F	G	H	I	J	K	L	M	N	O
200	DATA SET 22						DATA SET 24				
201		NORTH	SOUTH	EAST	WEST			NORTH	SOUTH	EAST	WEST
202	JAN	585.00	645.00	283.00	130.00		JUN	195	214	94	43
203	FEB	505.00	395.00	253.70	259.00		JUL	168	131	84	86
204	MAR	319.00	163.05	219.00	426.70		AUG	106	54	73	142
205	APR	263.75	24.13	203.87	526.00		SEP	88	8	68	175
206	MAY	432.87	121.38	52.71	361.30		OCT	144	40	18	120
207	JUN	213.01	247.79	158.52	459.00		NOV	71	82	53	153
208	JUL	366.91	337.00	284.00	605.00		DEC	122	112	94	201

A	E	F
57	**Survey Response**	
58	Q1	7
59	Q2	7
60	Q3	7
61	Q4	3
62	Q5	2
63	Q6	4
64	Q7	5
65	Q8	2
66	Q9	8
67	Q10	4
68	Q11	7
69	Q12	2
70	Q13	1
71	Q14	7
72	Q15	8
73	Q16	8
74	Q17	9

A	O	P	Q	R	S	T
1	Msg	Your Response Must Be a Numb				
2		Between and Please, Try Agai				
3						
4	menuid	Menu Processing ...				
5	Msg2	That is Not a Valid Response.				
6		Please, Try Again.				

```
A:A1:    'Main
A:B1:    '{APPLICATION.DISPLAY "none,no,no,no,a..b:a1..b2"}
A:D1:    @RAND
A:E1:    @ROUND(@RAND*1000,0)*@IF(D$1<0.5,-1,1)
A:F1:    '{LET I35,@NOW:VALUE}
A:G1:    '{graphview b2hh}
A:H1:    '{GRAPHCHAR G35}
A:I1:    '{LET J35,@NOW:VALUE}
A:J1:    '{if @@("G35")<"1"}
A:K1:    '{if @@("G35")>"4"}
A:L1:    '{if @@("G35")="~"}{Branch ShowMenu}
A:M1:    '{BEEP}{Message Msg,28,13,0}
A:N1:    '{Branch Chart1}
A:O1:    'Msg
A:P1:    'Your Response Must Be a Number
A:B2:    '{setobjectproperty "/File.hidden","yes"}
A:D2:    @RAND
A:E2:    @ROUND(@RAND*1000,0)*@IF(D$2<0.5,-1,1)
A:F2:    '{LET I37,@NOW:VALUE}
A:G2:    '{graphview b2lh}
A:H2:    '{GRAPHCHAR G37}
A:I2:    '{LET J37,@NOW:VALUE}
A:J2:    '{if @@("G37")<"1"}
A:K2:    '{if @@("G37")>"4"}
A:L2:    '{if @@("G37")="~"}{Branch ShowMenu}
A:M2:    '{BEEP}{Message Msg,28,13,0}
A:N2:    '{Branch Chart2}
A:P2:    'Between
A:Q2:    ^1
A:R2:    "and
A:S2:    ^4
A:T2:    "Please, Try Again.
A:B3:    '{setobjectproperty "/EDIT.hidden","yes"}
A:D3:    @RAND
A:E3:    @ROUND(@RAND*1000,0)*@IF(D$3<0.5,-1,1)
A:F3:    '{LET I40,@NOW:VALUE}
A:G3:    '{graphview b3hl}
A:H3:    '{GRAPHCHAR G40}
A:I3:    '{LET J40,@NOW:VALUE}
A:J3:    '{if @@("G40")<"1"}
A:K3:    '{if @@("G40")>"4"}
A:L3:    '{if @@("G40")="~"}{Branch ShowMenu}
A:M3:    '{BEEP}{Message Msg,28,13,0}
A:N3:    '{Branch Chart3}
A:B4:    '{setobjectproperty "/BLOCK.hidden","yes"}
A:D4:    @RAND
A:E4:    @ROUND(@RAND*1000,0)*@IF(D$4<0.5,-1,1)
A:F4:    '{LET I42,@NOW:VALUE}
A:G4:    '{graphview b3ll}
A:H4:    '{GRAPHCHAR G42}
A:I4:    '{LET J42,@NOW:VALUE}
A:J4:    '{if @@("G42")<"1"}
A:K4:    '{if @@("G42")>"4"}
A:L4:    '{if @@("G42")="~"}{Branch ShowMenu}
A:M4:    '{BEEP}{Message Msg,28,13,0}
A:N4:    '{Branch Chart4}
A:P4:    'Menu Processing ...
A:B5:    '{setobjectproperty "/DATA.hidden","yes"}
A:D5:    @RAND
A:E5:    @ROUND(@RAND*1000,0)*@IF(D$5<0.5,-1,1)
A:F5:    '{LET I43,@NOW:VALUE}
```

```
A:G5:   '{graphview l2hh}
A:H5:   '{GRAPHCHAR G43}
A:I5:   '{LET J43,@NOW:VALUE}
A:J5:   '{if @@("G43")<"1"}
A:K5:   '{if @@("G43")>"4"}
A:L5:   '{if @@("G43")="~"}{Branch ShowMenu}
A:M5:   '{BEEP}{Message Msg,28,13,0}
A:N5:   '{Branch Chart5}
A:O5:   'Msg2
A:P5:   'That is Not a Valid Response.
A:B6:   '{setobjectproperty "/TOOLS.hidden","yes"}
A:D6:   @RAND
A:E6:   @ROUND(@RAND*1000,0)*@IF(D$6<0.5,-1,1)
A:F6:   '{LET I45,@NOW:VALUE}
A:G6:   '{graphview l2lh}
A:H6:   '{GRAPHCHAR G45}
A:I6:   '{LET J45,@NOW:VALUE}
A:J6:   '{if @@("G45")<"1"}
A:K6:   '{if @@("G45")>"4"}
A:L6:   '{if @@("G45")="~"}{Branch ShowMenu}
A:M6:   '{BEEP}{Message Msg,28,13,0}
A:N6:   '{Branch Chart6}
A:P6:   "Please, Try Again.
A:B7:   '{setobjectproperty "/GRAPH.hidden","yes"}
A:D7:   @RAND
A:E7:   @ROUND(@RAND*1000,0)*@IF(D$7<0.5,-1,1)
A:F7:   '{LET I48,@NOW:VALUE}
A:G7:   '{graphview l3hl}
A:H7:   '{GRAPHCHAR G48}
A:I7:   '{LET J48,@NOW:VALUE}
A:J7:   '{if @@("G48")<"1"}
A:K7:   '{if @@("G48")>"4"}
A:L7:   '{if @@("G48")="~"}{Branch ShowMenu}
A:M7:   '{BEEP}{Message Msg,28,13,0}
A:N7:   '{Branch Chart7}
A:B8:   '{setobjectproperty "/PROPERTY.hidden","yes"}
A:D8:   @RAND
A:E8:   @ROUND(@RAND*1000,0)*@IF(D$8<0.5,-1,1)
A:F8:   '{LET I50,@NOW:VALUE}
A:G8:   '{graphview l3ll}
A:H8:   '{GRAPHCHAR G50}
A:I8:   '{LET J50,@NOW:VALUE}
A:J8:   '{if @@("G50")<"1"}
A:K8:   '{if @@("G50")>"4"}
A:L8:   '{if @@("G50")="~"}{Branch ShowMenu}
A:M8:   '{BEEP}{Message Msg,28,13,0}
A:N8:   '{Branch Chart8}
A:B9:   '{setobjectproperty "/WINDOW.hidden","yes"}
A:D9:   @RAND
A:E9:   @ROUND(@RAND*1000,0)*@IF(D$9<0.5,-1,1)
A:F9:   '{LET I52,@NOW:VALUE}
A:G9:   '{graphview mb2}
A:H9:   '{GRAPHCHAR G52}
A:I9:   '{LET J52,@NOW:VALUE}
A:J9:   '{if @@("G52")<"1"}
A:K9:   '{if @@("G52")>"4"}
A:L9:   '{if @@("G52")="~"}{Branch ShowMenu}
A:M9:   '{BEEP}{Message Msg,28,13,0}
A:N9:   '{Branch Chart9}
A:B10:  '{setobjectproperty "/HELP.hidden","yes"}
A:D10:  @RAND
```

```
A:E10:    @ROUND(@RAND*1000,0)*@IF(D$10<0.5,-1,1)
A:F10:    '{LET I31,@NOW:VALUE}
A:G10:    '{graphview thh}
A:H10:    '{GRAPHCHAR G31}
A:I10:    '{LET J31,@NOW:VALUE}
A:J10:    '{if @@("G31")<"1"}
A:K10:    '{if @@("G31")>"4"}
A:L10:    '{if @@("G31")="~"}{Branch ShowMenu}
A:M10:    '{BEEP}{Message Msg,28,13,0}
A:N10:    '{Branch Chart10}
A:B11:    '{breakoff}
A:D11:    @RAND
A:E11:    @ROUND(@RAND*1000,0)*@IF(D$11<0.5,-1,1)
A:F11:    '{LET I33,@NOW:VALUE}
A:G11:    '{graphview tlh}
A:H11:    '{GRAPHCHAR G33}
A:I11:    '{LET J33,@NOW:VALUE}
A:J11:    '{if @@("G33")<"1"}
A:K11:    '{if @@("G33")>"4"}
A:L11:    '{if @@("G33")="~"}{Branch ShowMenu}
A:M11:    '{BEEP}{Message Msg,28,13,0}
A:N11:    '{Branch Chart11}
A:A12:    'Sort
A:B12:    '{sort.reset}
A:E12:    -1
A:F12:    '{LET I54,@NOW:VALUE}
A:G12:    '{graphview ml2}
A:H12:    '{GRAPHCHAR G54}
A:I12:    '{LET J54,@NOW:VALUE}
A:J12:    '{if @@("G54")<"1"}
A:K12:    '{if @@("G54")>"4"}
A:L12:    '{if @@("G54")="~"}{Branch ShowMenu}
A:M12:    '{BEEP}{Message Msg,28,13,0}
A:N12:    '{Branch Chart12}
A:B13:    '{sort.block e1..I25}
A:E13:    0
A:F13:    '{LET I51,@NOW:VALUE}
A:G13:    '{graphview mt}
A:H13:    '{GRAPHCHAR G51}
A:I13:    '{LET J51,@NOW:VALUE}
A:J13:    '{if @@("G51")<"1"}
A:K13:    '{if @@("G51")>"4"}
A:L13:    '{if @@("G51")="~"}{Branch ShowMenu}
A:M13:    '{BEEP}{Message Msg,28,13,0}
A:N13:    '{Branch Chart13}
A:B14:    '{sort.key_1 e1}
A:E14:    1
A:F14:    '{LET I55,@NOW:VALUE}
A:G14:    '{graphview ml3}
A:H14:    '{GRAPHCHAR G55}
A:I14:    '{LET J55,@NOW:VALUE}
A:J14:    '{if @@("G55")<"1"}
A:K14:    '{if @@("G55")>"4"}
A:L14:    '{if @@("G55")="~"}{Branch ShowMenu}
A:M14:    '{BEEP}{Message Msg,28,13,0}
A:N14:    '{Branch Chart14}
A:B15:    '{sort.order_1 ascending}
A:E15:    @ROUND(@RAND*1000,0)*@IF(D$7<0.5,1,-1)
A:F15:    '{LET I36,@NOW:VALUE}
A:G15:    '{graphview b2hl}
A:H15:    '{GRAPHCHAR G36}
```

```
A:I15:    '{LET J36,@NOW:VALUE}
A:J15:    '{if @@("G36")<"1"}
A:K15:    '{if @@("G36")>"4"}
A:L15:    '{if @@("G36")="~"}{Branch ShowMenu}
A:M15:    '{BEEP}{Message Msg,28,13,0}
A:N15:    '{Branch Chart15}
A:B16:    '{sort.go}
A:E16:    @ROUND(@RAND*1000,0)*@IF(D$8<0.5,1,-1)
A:F16:    '{LET I38,@NOW:VALUE}
A:G16:    '{graphview b2ll}
A:H16:    '{GRAPHCHAR G38}
A:I16:    '{LET J38,@NOW:VALUE}
A:J16:    '{if @@("G38")<"1"}
A:K16:    '{if @@("G38")>"4"}
A:L16:    '{if @@("G38")="~"}{Branch ShowMenu}
A:M16:    '{BEEP}{Message Msg,28,13,0}
A:N16:    '{Branch Chart16}
A:B17:    '{Windowhide}
A:E17:    @ROUND(@RAND*1000,0)*@IF(D$5<0.5,1,-1)
A:F17:    '{LET I39,@NOW:VALUE}
A:G17:    '{graphview b3hh}
A:H17:    '{GRAPHCHAR G39}
A:I17:    '{LET J39,@NOW:VALUE}
A:J17:    '{if @@("G39")<"1"}
A:K17:    '{if @@("G39")>"4"}
A:L17:    '{if @@("G39")="~"}{Branch ShowMenu}
A:M17:    '{BEEP}{Message Msg,28,13,0}
A:N17:    '{Branch Chart17}
A:B18:    '{addmenu /file, menuid}
A:E18:    @ROUND(@RAND*1000,0)*@IF(D$6<0.5,1,-1)
A:F18:    '{LET I41,@NOW:VALUE}
A:G18:    '{graphview b3lh}
A:H18:    '{GRAPHCHAR G41}
A:I18:    '{LET J41,@NOW:VALUE}
A:J18:    '{if @@("G41")<"1"}
A:K18:    '{if @@("G41")>"4"}
A:L18:    '{if @@("G41")="~"}{Branch ShowMenu}
A:M18:    '{BEEP}{Message Msg,28,13,0}
A:N18:    '{Branch Chart18}
A:B19:    '{graphview start}
A:E19:    @ROUND(@RAND*1000,0)*@IF(D$3<0.5,1,-1)
A:F19:    '{LET I44,@NOW:VALUE}
A:G19:    '{graphview l2hl}
A:H19:    '{GRAPHCHAR G44}
A:I19:    '{LET J44,@NOW:VALUE}
A:J19:    '{if @@("G44")<"1"}
A:K19:    '{if @@("G44")>"4"}
A:L19:    '{if @@("G44")="~"}{Branch ShowMenu}
A:M19:    '{BEEP}{Message Msg,28,13,0}
A:N19:    '{Branch Chart19}
A:B20:    +F1
A:E20:    @ROUND(@RAND*1000,0)*@IF(D$4<0.5,1,-1)
A:F20:    '{LET I46,@NOW:VALUE}
A:G20:    '{graphview l2ll}
A:H20:    '{GRAPHCHAR G46}
A:I20:    '{LET J46,@NOW:VALUE}
A:J20:    '{if @@("G46")<"1"}
A:K20:    '{if @@("G46")>"4"}
A:L20:    '{if @@("G46")="~"}{Branch ShowMenu}
A:M20:    '{BEEP}{Message Msg,28,13,0}
A:N20:    '{Branch Chart20}
```

```
A:A21:   'Chart1
A:B21:   +G1
A:E21:   @ROUND(@RAND*1000,0)*@IF(D$1<0.5,1,-1)
A:F21:   '{LET I47,@NOW:VALUE}
A:G21:   '{graphview l3hh}
A:H21:   '{GRAPHCHAR G47}
A:I21:   '{LET J47,@NOW:VALUE}
A:J21:   '{if @@("G47")<"1"}
A:K21:   '{if @@("G47")>"4"}
A:L21:   '{if @@("G47")="~"}{Branch ShowMenu}
A:M21:   '{BEEP}{Message Msg,28,13,0}
A:N21:   '{Branch Chart21}
A:B22:   +H1
A:E22:   @ROUND(@RAND*1000,0)*@IF(D$2<0.5,1,-1)
A:F22:   '{LET I49,@NOW:VALUE}
A:G22:   '{graphview l3lh}
A:H22:   '{GRAPHCHAR G49}
A:I22:   '{LET J49,@NOW:VALUE}
A:J22:   '{if @@("G49")<"1"}
A:K22:   '{if @@("G49")>"4"}
A:L22:   '{if @@("G49")="~"}{Branch ShowMenu}
A:M22:   '{BEEP}{Message Msg,28,13,0}
A:N22:   '{Branch Chart22}
A:B23:   +I1
A:E23:   @ROUND(@RAND*1000,0)*@IF(D$9<0.5,1,-1)
A:F23:   '{LET I53,@NOW:VALUE}
A:G23:   '{graphview mb3}
A:H23:   '{GRAPHCHAR G53}
A:I23:   '{LET J53,@NOW:VALUE}
A:J23:   '{if @@("G53")<"1"}
A:K23:   '{if @@("G53")>"4"}
A:L23:   '{if @@("G53")="~"}{Branch ShowMenu}
A:M23:   '{BEEP}{Message Msg,28,13,0}
A:N23:   '{Branch Chart23}
A:B24:   +L1
A:E24:   @ROUND(@RAND*1000,0)*@IF(D$10<0.5,1,-1)
A:F24:   '{LET I32,@NOW:VALUE}
A:G24:   '{graphview thl}
A:H24:   '{GRAPHCHAR G32}
A:I24:   '{LET J32,@NOW:VALUE}
A:J24:   '{if @@("G32")<"1"}
A:K24:   '{if @@("G32")>"4"}
A:L24:   '{if @@("G32")="~"}{Branch ShowMenu}
A:M24:   '{BEEP}{Message Msg,28,13,0}
A:N24:   '{Branch Chart24}
A:B25:   +J1&M1&N1
A:E25:   @ROUND(@RAND*1000,0)*@IF(D$11<0.5,1,-1)
A:F25:   '{LET I34,@NOW:VALUE}
A:G25:   '{graphview tll}
A:H25:   '{GRAPHCHAR G34}
A:I25:   '{LET J34,@NOW:VALUE}
A:J25:   '{if @@("G34")<"1"}
A:K25:   '{if @@("G34")>"4"}
A:L25:   '{if @@("G34")="~"}{Branch ShowMenu}
A:M25:   '{BEEP}{Message Msg,28,13,0}
A:N25:   '{Branch Chart25}
A:B26:   +K1&M1&N1
A:B27:   +F2
A:A28:   'Chart2
A:B28:   +G2
A:B29:   +H2
```

```
A:E29:    'RESPONSE SECTION
A:B30:    +I2
A:E30:    'NAME
A:F30:    ^KNOWN
A:G30:    ^OBSRVD
A:H30:    ^CORCT
A:I30:    ^TIME ST
A:J30:    ^TIME END
A:K30:    ^RESP TIME
A:B31:    +L2
A:E31:    'THH
A:F31:    ^3
A:G31:    '3
A:H31:    @IF(@VALUE(F31)=@VALUE(G31),"1","0")
A:I31:    34438.387719907
A:J31:    34438.387789352
A:K31:    @ABS(J31-I31)*86400
A:B32:    +J2&M2&N2
A:E32:    'THL
A:F32:    ^1
A:G32:    '1
A:H32:    @IF(@VALUE(F32)=@VALUE(G32),"1","0")
A:I32:    34438.386354167
A:J32:    34438.386412037
A:K32:    @ABS(J32-I32)*86400
A:B33:    +K2&M2&N2
A:E33:    'TLH
A:F33:    ^2
A:G33:    '2
A:H33:    @IF(@VALUE(F33)=@VALUE(G33),"1","0")
A:I33:    34438.387326389
A:J33:    34438.387395833
A:K33:    @ABS(J33-I33)*86400
A:B34:    +F3
A:E34:    'TLL
A:F34:    ^4
A:G34:    '4
A:H34:    @IF(@VALUE(F34)=@VALUE(G34),"1","0")
A:I34:    34438.388043981
A:J34:    34438.388090278
A:K34:    @ABS(J34-I34)*86400
A:A35:    'Chart3
A:B35:    +G3
A:E35:    'B2HH
A:F35:    ^3
A:G35:    '3
A:H35:    @IF(@VALUE(F35)=@VALUE(G35),"1","0")
A:I35:    34438.387789352
A:J35:    34438.387847222
A:K35:    @ABS(J35-I35)*86400
A:B36:    +H3
A:E36:    'B2HL
A:F36:    ^1
A:G36:    '1
A:H36:    @IF(@VALUE(F36)=@VALUE(G36),"1","0")
A:I36:    34438.387962963
A:J36:    34438.388043981
A:K36:    @ABS(J36-I36)*86400
A:B37:    +I3
A:E37:    'B2LH
A:F37:    ^2
```

A:G37:	"2
A:H37:	@IF(@VALUE(F37)=@VALUE(G37),"1","0")
A:I37:	34438.386238426
A:J37:	34438.386354167
A:K37:	@ABS(J37-I37)*86400
A:B38:	+L3
A:E38:	'B2LL
A:F38:	^4
A:G38:	'4
A:H38:	@IF(@VALUE(F38)=@VALUE(G38),"1","0")
A:I38:	34438.386712963
A:J38:	34438.386770833
A:K38:	@ABS(J38-I38)*86400
A:B39:	+J3&M3&N3
A:D39:	'
A:E39:	'B3HH
A:F39:	^1
A:G39:	"3
A:H39:	@IF(@VALUE(F39)=@VALUE(G39),"1","0")
A:I39:	34438.388090278
A:J39:	34438.38818287
A:K39:	@ABS(J39-I39)*86400
A:B40:	+K3&M3&N3
A:E40:	'B3HL
A:F40:	^4
A:G40:	"1
A:H40:	@IF(@VALUE(F40)=@VALUE(G40),"1","0")
A:I40:	34438.388275463
A:J40:	34438.388402778
A:K40:	@ABS(J40-I40)*86400
A:B41:	+F4
A:E41:	'B3LH
A:F41:	^3
A:G41:	"2
A:H41:	@IF(@VALUE(F41)=@VALUE(G41),"1","0")
A:I41:	34438.3871875
A:J41:	34438.387256944
A:K41:	@ABS(J41-I41)*86400
A:A42:	'Chart4
A:B42:	+G4
A:E42:	'B3LL
A:F42:	^2
A:G42:	"3
A:H42:	@IF(@VALUE(F42)=@VALUE(G42),"1","0")
A:I42:	34438.386840278
A:J42:	34438.386956019
A:K42:	@ABS(J42-I42)*86400
A:B43:	+H4
A:E43:	'L2HH
A:F43:	^1
A:G43:	"3
A:H43:	@IF(@VALUE(F43)=@VALUE(G43),"1","0")
A:I43:	34438.38818287
A:J43:	34438.388275463
A:K43:	@ABS(J43-I43)*86400
A:B44:	+I4
A:E44:	'L2HL
A:F44:	^4
A:G44:	"2
A:H44:	@IF(@VALUE(F44)=@VALUE(G44),"1","0")
A:I44:	34438.387523148

A:J44: 34438.387604167
A:K44: @ABS(J44-I44)*86400
A:B45: +L4
A:E45: 'L2LH
A:F45: ^3
A:G45: '2
A:H45: @IF(@VALUE(F45)=@VALUE(G45),"1","0")
A:I45: 34438.387662037
A:J45: 34438.387719907
A:K45: @ABS(J45-I45)*86400
A:B46: +J4&M4&N4
A:E46: 'L2LL
A:F46: ^2
A:G46: '4
A:H46: @IF(@VALUE(F46)=@VALUE(G46),"1","0")
A:I46: 34438.386956019
A:J46: 34438.387083333
A:K46: @ABS(J46-I46)*86400
A:B47: +K4&M4&N4
A:E47: 'L3HH
A:F47: ^3
A:G47: '3
A:H47: @IF(@VALUE(F47)=@VALUE(G47),"1","0")
A:I47: 34438.386423611
A:J47: 34438.3865625
A:K47: @ABS(J47-I47)*86400
A:B48: +F5
A:E48: 'L3HL
A:F48: ^1
A:G48: '3
A:H48: @IF(@VALUE(F48)=@VALUE(G48),"1","0")
A:I48: 34438.3865625
A:J48: 34438.386712963
A:K48: @ABS(J48-I48)*86400
A:A49: 'Chart5
A:B49: +G5
A:E49: 'L3LH
A:F49: ^2
A:G49: '2
A:H49: @IF(@VALUE(F49)=@VALUE(G49),"1","0")
A:I49: 34438.387858796
A:J49: 34438.387962963
A:K49: @ABS(J49-I49)*86400
A:B50: +H5
A:E50: 'L3LL
A:F50: ^4
A:G50: '2
A:H50: @IF(@VALUE(F50)=@VALUE(G50),"1","0")
A:I50: 34438.386770833
A:J50: 34438.386828704
A:K50: @ABS(J50-I50)*86400
A:B51: +I5
A:E51: 'MT
A:F51: ^4
A:G51: '4
A:H51: @IF(@VALUE(F51)=@VALUE(G51),"1","0")
A:I51: 34438.387395833
A:J51: 34438.387453704
A:K51: @ABS(J51-I51)*86400
A:B52: +L5
A:E52: 'MB2

A:F52: ^2
A:G52: '2
A:H52: @IF(@VALUE(F52)=@VALUE(G52),"1","0")
A:I52: 34438.387604167
A:J52: 34438.387662037
A:K52: @ABS(J52-I52)*86400
A:B53: +J5&M5&N5
A:E53: 'MB3
A:F53: ^1
A:G53: '4
A:H53: @IF(@VALUE(F53)=@VALUE(G53),"1","0")
A:I53: 34438.387083333
A:J53: 34438.3871875
A:K53: @ABS(J53-I53)*86400
A:B54: +K5&M5&N5
A:E54: 'ML2
A:F54: ^2
A:G54: '2
A:H54: @IF(@VALUE(F54)=@VALUE(G54),"1","0")
A:I54: 34438.387256944
A:J54: 34438.387326389
A:K54: @ABS(J54-I54)*86400
A:B55: +F6
A:E55: 'ML3
A:F55: ^3
A:G55: '3
A:H55: @IF(@VALUE(F55)=@VALUE(G55),"1","0")
A:I55: 34438.387453704
A:J55: 34438.387523148
A:K55: @ABS(J55-I55)*86400
A:A56: 'Chart6
A:B56: +G6
A:I56: @MIN(I31..I55)
A:J56: @MAX(I31..I55)
A:K56: @ABS(J56-I56)*86400
A:L56: +K56/60
A:B57: +H6
A:E57: 'Survey Response
A:B58: +I6
A:E58: ^Q1
A:F58: '7
A:B59: +L6
A:E59: ^Q2
A:F59: '7
A:B60: +J6&M6&N6
A:E60: ^Q3
A:F60: '7
A:B61: +K6&M6&N6
A:E61: ^Q4
A:F61: '3
A:B62: +F7
A:E62: ^Q5
A:F62: '2
A:A63: 'Chart7
A:B63: +G7
A:E63: ^Q6
A:F63: '4
A:B64: +H7
A:E64: ^Q7
A:F64: '5
A:B65: +I7

A:E65:	^Q8
A:F65:	'2
A:B66:	+L7
A:E66:	^Q9
A:F66:	'8
A:B67:	+J7&M7&N7
A:E67:	^Q10
A:F67:	'4
A:B68:	+K7&M7&N7
A:E68:	^Q11
A:F68:	'7
A:B69:	+F8
A:E69:	^Q12
A:F69:	'2
A:A70:	'Chart8
A:B70:	+G8
A:E70:	^Q13
A:F70:	'1
A:B71:	+H8
A:E71:	^Q14
A:F71:	'7
A:B72:	+I8
A:E72:	^Q15
A:F72:	'8
A:B73:	+L8
A:E73:	^Q16
A:F73:	'8
A:B74:	+J8&M8&N8
A:E74:	^Q17
A:F74:	'9
A:B75:	+K8&M8&N8
A:B76:	+F9
A:A77:	'Chart9
A:B77:	+G9
A:B78:	+H9
A:B79:	+I9
A:B80:	+L9
A:B81:	+J9&M9&N9
A:B82:	+K9&M9&N9
A:B83:	+F10
A:A84:	'Chart10
A:B84:	+G10
A:B85:	+H10
A:B86:	+I10
A:B87:	+L10
A:B88:	+J10&M10&N10
A:B89:	+K10&M10&N10
A:B90:	+F11
A:A91:	'Chart11
A:B91:	+G11
A:B92:	+H11
A:B93:	+I11
A:B94:	+L11
A:B95:	+J11&M11&N11
A:B96:	+K11&M11&N11
A:B97:	+F12
A:A98:	'Chart12
A:B98:	+G12
A:B99:	+H12
A:B100:	+I12
A:B101:	+L12

A:B102:	+J12&M12&N12
A:B103:	+K12&M12&N12
A:B104:	+F13
A:A105:	'Chart13
A:B105:	+G13
A:B106:	+H13
A:B107:	+I13
A:B108:	+L13
A:B109:	+J13&M13&N13
A:B110:	+K13&M13&N13
A:B111:	+F14
A:A112:	'Chart14
A:B112:	+G14
A:B113:	+H14
A:B114:	+I14
A:B115:	+L14
A:B116:	+J14&M14&N14
A:B117:	+K14&M14&N14
A:B118:	+F15
A:A119:	'Chart15
A:B119:	+G15
A:B120:	+H15
A:B121:	+I15
A:B122:	+L15
A:B123:	+J15&M15&N15
A:B124:	+K15&M15&N15
A:B125:	+F16
A:A126:	'Chart16
A:B126:	+G16
A:B127:	+H16
A:B128:	+I16
A:B129:	+L16
A:B130:	+J16&M16&N16
A:B131:	+K16&M16&N16
A:B132:	+F17
A:A133:	'Chart17
A:B133:	+G17
A:B134:	+H17
A:B135:	+I17
A:B136:	+L17
A:B137:	+J17&M17&N17
A:B138:	+K17&M17&N17
A:B139:	+F18
A:A140:	'Chart18
A:B140:	+G18
A:B141:	+H18
A:B142:	+I18
A:B143:	+L18
A:B144:	+J18&M18&N18
A:B145:	+K18&M18&N18
A:B146:	+F19
A:A147:	'Chart19
A:B147:	+G19
A:B148:	+H19
A:B149:	+I19
A:E149:	'
A:B150:	+L19
A:E150:	'DATA SET 11
A:K150:	'MT, MB2
A:B151:	+J19&M19&N19
A:F151:	^NORTH

A:G151:	^SOUTH
A:H151:	^EAST
A:I151:	^WEST
A:L151:	^NORTH
A:M151:	^SOUTH
A:N151:	^EAST
A:O151:	^WEST
A:B152:	+K19&M19&N19
A:E152:	^1987
A:F152:	371
A:G152:	596
A:H152:	679
A:I152:	905
A:K152:	^1
A:L152:	516
A:M152:	156
A:N152:	224
A:O152:	79
A:B153:	+F20
A:E153:	^1988
A:F153:	399
A:G153:	432
A:H153:	749
A:I153:	692
A:K153:	^2
A:L153:	131
A:M153:	880
A:N153:	460
A:O153:	873
A:A154:	'Chart20
A:B154:	+G20
A:E154:	^1989
A:F154:	531
A:G154:	379
A:H154:	632
A:I154:	700
A:K154:	^3
A:L154:	800
A:M154:	241
A:N154:	329
A:O154:	975
A:B155:	+H20
A:E155:	^1990
A:F155:	442
A:G155:	343
A:H155:	556
A:I155:	648
A:K155:	^4
A:L155:	527
A:M155:	469
A:N155:	413
A:O155:	262
A:B156:	+I20
A:E156:	^1991
A:F156:	507
A:G156:	398
A:H156:	620
A:I156:	540
A:K156:	^5
A:L156:	253
A:M156:	870

A:N156: 133
A:O156: 506
A:B157: +L20
A:E157: ^1992
A:F157: 691
A:G157: 556
A:H157: 730
A:I157: 489
A:K157: ^6
A:L157: 399
A:M157: 518
A:N157: 877
A:O157: 275
A:B158: +J20&M20&N20
A:E158: ^1993
A:F158: 589
A:G158: 353
A:H158: 858
A:I158: 759
A:K158: ^7
A:L158: 98
A:M158: 528
A:N158: 252
A:O158: 267
A:B159: +K20&M20&N20
A:B160: +F21
A:E160: 'DATA SET 12
A:K160: 'MB3
A:A161: 'Chart21
A:B161: +G21
A:F161: ^NORTH
A:G161: ^SOUTH
A:H161: ^EAST
A:I161: ^WEST
A:L161: ^NORTH
A:M161: ^SOUTH
A:N161: ^EAST
A:O161: ^WEST
A:B162: +H21
A:E162: ^JAN
A:F162: +F152-300
A:G162: +G152-300
A:H162: +H152-300
A:I162: +I152-300
A:K162: ^JAN
A:L162: 874
A:M162: 810
A:N162: 793
A:O162: 474
A:B163: +I21
A:E163: ^FEB
A:F163: +F153-300
A:G163: +G153-300
A:H163: +H153-300
A:I163: +I153-300
A:K163: ^FEB
A:L163: 740
A:M163: 573
A:N163: 895
A:O163: 783
A:B164: +L21

A:E164: ^MAR
A:F164: +F154-300
A:G164: +G154-300
A:H164: +H154-300
A:I164: +I154-300
A:K164: ^MAR
A:L164: 169
A:M164: 786
A:N164: 504
A:O164: 920
A:B165: +J21&M21&N21
A:E165: ^APR
A:F165: +F155-300
A:G165: +G155-300
A:H165: +H155-300
A:I165: +I155-300
A:K165: ^APR
A:L165: 268
A:M165: 167
A:N165: 332
A:O165: 466
A:B166: +K21&M21&N21
A:E166: ^MAY
A:F166: +F156-300
A:G166: +G156-300
A:H166: +H156-300
A:I166: +I156-300
A:K166: ^MAY
A:L166: 500
A:M166: 181
A:N166: 359
A:O166: 483
A:B167: +F22
A:E167: ^JUN
A:F167: +F157-300
A:G167: +G157-300
A:H167: +H157-300
A:I167: +I157-300
A:K167: ^JUN
A:L167: 89
A:M167: 895
A:N167: 661
A:O167: 250
A:A168: 'Chart22
A:B168: +G22
A:E168: ^JUL
A:F168: +F158-300
A:G168: +G158-300
A:H168: +H158-300
A:I168: +I158-300
A:K168: ^JUL
A:L168: 279
A:M168: 190
A:N168: 151
A:O168: 942
A:B169: +H22
A:B170: +I22
A:E170: 'DATA SET 13
A:K170: 'ML2
A:B171: +L22
A:F171: ^NORTH

A:G171:	^SOUTH
A:H171:	^EAST
A:I171:	^WEST
A:L171:	^NORTH
A:M171:	^SOUTH
A:N171:	^EAST
A:O171:	^WEST
A:B172:	+J22&M22&N22
A:E172:	^1980
A:F172:	+F162*1.33
A:G172:	+G162*1.33
A:H172:	+H162*1.33
A:I172:	+I162*1.33
A:K172:	^1
A:L172:	282
A:M172:	176
A:N172:	819
A:O172:	108
A:B173:	+K22&M22&N22
A:E173:	^1981
A:F173:	+F163*1.33
A:G173:	+G163*1.33
A:H173:	+H163*1.33
A:I173:	+I163*1.33
A:K173:	^2
A:L173:	267
A:M173:	701
A:N173:	56
A:O173:	179
A:B174:	+F23
A:E174:	^1982
A:F174:	+F164*1.33
A:G174:	+G164*1.33
A:H174:	+H164*1.33
A:I174:	+I164*1.33
A:K174:	^3
A:L174:	407
A:M174:	20
A:N174:	692
A:O174:	333
A:A175:	'Chart23
A:B175:	+G23
A:E175:	^1983
A:F175:	+F165*1.33
A:G175:	+G165*1.33
A:H175:	+H165*1.33
A:I175:	+I165*1.33
A:K175:	^4
A:L175:	913
A:M175:	463
A:N175:	580
A:O175:	440
A:B176:	+H23
A:E176:	^1984
A:F176:	+F166*1.33
A:G176:	+G166*1.33
A:H176:	+H166*1.33
A:I176:	+I166*1.33
A:K176:	^5
A:L176:	501
A:M176:	702

A:N176: 911
A:O176: 481
A:B177: +I23
A:E177: ^1985
A:F177: +F167*1.33
A:G177: +G167*1.33
A:H177: +H167*1.33
A:I177: +I167*1.33
A:K177: ^6
A:L177: 655
A:M177: 330
A:N177: 759
A:O177: 264
A:B178: +L23
A:E178: ^1986
A:F178: +F168*1.33
A:G178: +G168*1.33
A:H178: +H168*1.33
A:I178: +I168*1.33
A:K178: ^7
A:L178: 553
A:M178: 274
A:N178: 443
A:O178: 213
A:B179: +J23&M23&N23
A:B180: +K23&M23&N23
A:E180: 'DATA SET 14
A:K180: 'ML3
A:B181: +F24
A:F181: ^NORTH
A:G181: ^SOUTH
A:H181: ^EAST
A:I181: ^WEST
A:L181: ^NORTH
A:M181: ^SOUTH
A:N181: ^EAST
A:O181: ^WEST
A:A182: 'Chart24
A:B182: +G24
A:E182: ^ JUN
A:F182: +F172/4
A:G182: +G172/4
A:H182: +H172/4
A:I182: +I172/4
A:K182: ^JAN
A:L182: 848
A:M182: 943
A:N182: 227
A:O182: 413
A:B183: +H24
A:E183: ^JUL
A:F183: +F173/4
A:G183: +G173/4
A:H183: +H173/4
A:I183: +I173/4
A:K183: ^FEB
A:L183: 790
A:M183: 859
A:N183: 849
A:O183: 516
A:B184: +I24

A:E184: ^AUG
A:F184: +F174/4
A:G184: +G174/4
A:H184: +H174/4
A:I184: +I174/4
A:K184: ^MAR
A:L184: 190
A:M184: 257
A:N184: 162
A:O184: 869
A:B185: +L24
A:E185: ^SEP
A:F185: +F175/4
A:G185: +G175/4
A:H185: +H175/4
A:I185: +I175/4
A:K185: ^APR
A:L185: 920
A:M185: 351
A:N185: 942
A:O185: 555
A:B186: +J24&M24&N24
A:E186: ^OCT
A:F186: +F176/4
A:G186: +G176/4
A:H186: +H176/4
A:I186: +I176/4
A:K186: ^MAY
A:L186: 217
A:M186: 752
A:N186: 922
A:O186: 949
A:B187: +K24&M24&N24
A:E187: ^NOV
A:F187: +F177/4
A:G187: +G177/4
A:H187: +H177/4
A:I187: +I177/4
A:K187: ^JUN
A:L187: 57
A:M187: 923
A:N187: 675
A:O187: 636
A:B188: +F25
A:E188: ^DEC
A:F188: +F178/4
A:G188: +G178/4
A:H188: +H178/4
A:I188: +I178/4
A:K188: ^JUL
A:L188: 778
A:M188: 38
A:N188: 575
A:O188: 775
A:A189: 'Chart25
A:B189: +G25
A:B190: +H25
A:E190: 'DATA SET 21
A:B191: +I25
A:F191: ^NORTH
A:G191: ^SOUTH

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A:H191:   ^EAST
A:I191:   ^WEST
A:B192:   +L25
A:E192:   ^1987
A:F192:   885
A:G192:   945
A:H192:   583
A:I192:   430
A:B193:   +J25&M25&N25
A:E193:   ^1988
A:F193:   805
A:G193:   695
A:H193:   553.7
A:I193:   559
A:B194:   +K25&M25&N25
A:E194:   ^1989
A:F194:   619
A:G194:   463.05
A:H194:   519
A:I194:   726.7
A:B195:   '{GRAPHVIEW Qstart}
A:E195:   ^1990
A:F195:   563.745
A:G195:   324.135
A:H195:   503.867
A:I195:   826
A:A196:   'Question1
A:B196:   '{GRAPHVIEW Q1}
A:E196:   ^1991
A:F196:   732.8685
A:G196:   421.3755
A:H196:   352.7069
A:I196:   661.297
A:B197:   '{GRAPHCHAR F58}
A:E197:   ^1992
A:F197:   513.00795
A:G197:   547.78815
A:H197:   458.51897
A:I197:   759
A:B198:   '{if @@("F58")="~"}{Branch ShowMenu}
A:E198:   ^1993
A:F198:   666.910335
A:G198:   637
A:H198:   584
A:I198:   905
A:B199:   '{if @@("F58")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question1}
A:B200:   '{if @@("F58")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question1}
A:E200:   'DATA SET 22
A:A201:   'Question2
A:B201:   '{GRAPHVIEW Q2}
A:F201:   ^NORTH
A:G201:   ^SOUTH
A:H201:   ^EAST
A:I201:   ^WEST
A:B202:   '{GRAPHCHAR F59}
A:E202:   ^JAN
A:F202:   +F192-300
A:G202:   +G192-300
A:H202:   +H192-300
A:I202:   +I192-300
A:B203:   '{if @@("F59")="~"}{Branch ShowMenu}
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A:E203:   ^FEB
A:F203:   +F193-300
A:G203:   +G193-300
A:H203:   +H193-300
A:I203:   +I193-300
A:B204:   '{if @@("F59")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question2}
A:E204:   ^MAR
A:F204:   +F194-300
A:G204:   +G194-300
A:H204:   +H194-300
A:I204:   +I194-300
A:B205:   '{if @@("F59")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question2}
A:E205:   ^APR
A:F205:   +F195-300
A:G205:   +G195-300
A:H205:   +H195-300
A:I205:   +I195-300
A:A206:   'Question3
A:B206:   '{GRAPHVIEW Q3}
A:E206:   ^MAY
A:F206:   +F196-300
A:G206:   +G196-300
A:H206:   +H196-300
A:I206:   +I196-300
A:B207:   '{GRAPHCHAR F60}
A:E207:   ^JUN
A:F207:   +F197-300
A:G207:   +G197-300
A:H207:   +H197-300
A:I207:   +I197-300
A:B208:   '{if @@("F60")="~"}{Branch ShowMenu}
A:E208:   ^JUL
A:F208:   +F198-300
A:G208:   +G198-300
A:H208:   +H198-300
A:I208:   +I198-300
A:B209:   '{if @@("F60")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question3}
A:B210:   '{if @@("F60")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question3}
A:E210:   'DATA SET 23
A:A211:   'Question4
A:B211:   '{GRAPHVIEW Q4}
A:F211:   ^NORTH
A:G211:   ^SOUTH
A:H211:   ^EAST
A:I211:   ^WEST
A:B212:   '{GRAPHCHAR F61}
A:E212:   ^1980
A:F212:   +F202*1.33
A:G212:   +G202*1.33
A:H212:   +H202*1.33
A:I212:   +I202*1.33
A:B213:   '{if @@("F61")="~"}{Branch ShowMenu}
A:E213:   ^1981
A:F213:   +F203*1.33
A:G213:   +G203*1.33
A:H213:   +H203*1.33
A:I213:   +I203*1.33
A:B214:   '{if @@("F61")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question4}
A:E214:   ^1982
A:F214:   +F204*1.33
A:G214:   +G204*1.33
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A:H214:   +H204*1.33
A:I214:   +I204*1.33
A:B215:   '{if @@("F61")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question4}
A:E215:   ^1983
A:F215:   +F205*1.33
A:G215:   +G205*1.33
A:H215:   +H205*1.33
A:I215:   +I205*1.33
A:A216:   'Question5
A:B216:   '{GRAPHVIEW Q5}
A:E216:   ^1984
A:F216:   +F206*1.33
A:G216:   +G206*1.33
A:H216:   +H206*1.33
A:I216:   +I206*1.33
A:B217:   '{GRAPHCHAR F62}
A:E217:   ^1985
A:F217:   +F207*1.33
A:G217:   +G207*1.33
A:H217:   +H207*1.33
A:I217:   +I207*1.33
A:B218:   '{if @@("F62")="~"}{Branch ShowMenu}
A:E218:   ^1986
A:F218:   +F208*1.33
A:G218:   +G208*1.33
A:H218:   +H208*1.33
A:I218:   +I208*1.33
A:B219:   '{if @@("F62")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question5}
A:B220:   '{if @@("F62")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question5}
A:E220:   'DATA SET 24
A:A221:   'Question6
A:B221:   '{GRAPHVIEW Q6}
A:F221:   ^NORTH
A:G221:   ^SOUTH
A:H221:   ^EAST
A:I221:   ^WEST
A:B222:   '{GRAPHCHAR F63}
A:E222:   ^ JUN
A:F222:   +F212/4
A:G222:   +G212/4
A:H222:   +H212/4
A:I222:   +I212/4
A:B223:   '{if @@("F63")="~"}{Branch ShowMenu}
A:E223:   ^JUL
A:F223:   +F213/4
A:G223:   +G213/4
A:H223:   +H213/4
A:I223:   +I213/4
A:B224:   '{if @@("F63")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question6}
A:E224:   ^AUG
A:F224:   +F214/4
A:G224:   +G214/4
A:H224:   +H214/4
A:I224:   +I214/4
A:B225:   '{if @@("F63")>"6"}{BEEP}{Message Msg2,28,13,0}{Branch Question6}
A:E225:   ^SEP
A:F225:   +F215/4
A:G225:   +G215/4
A:H225:   +H215/4
A:I225:   +I215/4
A:A226:   'Question7
```

```
A:B226:   '{GRAPHVIEW Q7}
A:E226:   ^OCT
A:F226:   +F216/4
A:G226:   +G216/4
A:H226:   +H216/4
A:I226:   +I216/4
A:B227:   '{GRAPHCHAR F64}
A:E227:   ^NOV
A:F227:   +F217/4
A:G227:   +G217/4
A:H227:   +H217/4
A:I227:   +I217/4
A:B228:   '{if @@("F64")="~"}{Branch ShowMenu}
A:E228:   ^DEC
A:F228:   +F218/4
A:G228:   +G218/4
A:H228:   +H218/4
A:I228:   +I218/4
A:B229:   '{if @@("F64")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question7}
A:B230:   '{if @@("F64")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question7}
A:A231:   'Question8
A:B231:   '{GRAPHVIEW Q8}
A:B232:   '{GRAPHCHAR F65}
A:B233:   '{if @@("F65")="~"}{Branch ShowMenu}
A:B234:   '{if @@("F65")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question8}
A:B235:   '{if @@("F65")>"2"}{BEEP}{Message Msg2,28,13,0}{Branch Question8}
A:A236:   'Question9
A:B236:   '{GRAPHVIEW Q9}
A:B237:   '{GRAPHCHAR F66}
A:B238:   '{if @@("F66")="~"}{Branch ShowMenu}
A:B239:   '{if @@("F66")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question9}
A:B240:   '{if @@("F66")>"8"}{BEEP}{Message Msg2,28,13,0}{Branch Question9}
A:A241:   'Question10
A:B241:   '{GRAPHVIEW Q10}
A:B242:   '{GRAPHCHAR F67}
A:B243:   '{if @@("F67")="~"}{Branch ShowMenu}
A:B244:   '{if @@("F67")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question10}
A:B245:   '{if @@("F67")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question10}
A:A246:   'Question11
A:B246:   '{GRAPHVIEW Q11}
A:B247:   '{GRAPHCHAR F68}
A:B248:   '{if @@("F68")="~"}{Branch ShowMenu}
A:B249:   '{if @@("F68")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question11}
A:B250:   '{if @@("F68")>"8"}{BEEP}{Message Msg2,28,13,0}{Branch Question11}
A:A251:   'Question12
A:B251:   '{GRAPHVIEW Q12}
A:B252:   '{GRAPHCHAR F69}
A:B253:   '{if @@("F69")="~"}{Branch ShowMenu}
A:B254:   '{if @@("F69")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question12}
A:B255:   '{if @@("F69")>"2"}{BEEP}{Message Msg2,28,13,0}{Branch Question12}
A:A256:   'Question13
A:B256:   '{GRAPHVIEW Q13}
A:B257:   '{GRAPHCHAR F70}
A:B258:   '{if @@("F70")="~"}{Branch ShowMenu}
A:B259:   '{if @@("F70")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question13}
A:B260:   '{if @@("F70")>"9"}{BEEP}{Message Msg2,28,13,0}{Branch Question13}
A:A261:   'Question14
A:B261:   '{GRAPHVIEW Q14}
A:B262:   '{GRAPHCHAR F71}
A:B263:   '{if @@("F71")="~"}{Branch ShowMenu}
A:B264:   '{if @@("F71")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question14}
```

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A:B265:  '{if @@("F71")>"7"}{BEEP}{Message Msg2,28,13,0}{Branch Question14}
A:A266:  'Question15
A:B266:  '{GRAPHVIEW Q15}
A:B267:  '{GRAPHCHAR F72}
A:B268:  '{if @@("F72")="~"}{Branch ShowMenu}
A:B269:  '{if @@("F72")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question15}
A:B270:  '{if @@("F72")>"8"}{BEEP}{Message Msg2,28,13,0}{Branch Question15}
A:A271:  'Question16
A:B271:  '{GRAPHVIEW Q16}
A:B272:  '{GRAPHCHAR F73}
A:B273:  '{if @@("F73")="~"}{Branch ShowMenu}
A:B274:  '{if @@("F73")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question16}
A:B275:  '{if @@("F73")>"8"}{BEEP}{Message Msg2,28,13,0}{Branch Question16}
A:A276:  'Question17
A:B276:  '{GRAPHVIEW Q17}
A:B277:  '{GRAPHCHAR F74}
A:B278:  '{if @@("F74")="~"}{Branch ShowMenu}
A:B279:  '{if @@("F74")<"1"}{BEEP}{Message Msg2,28,13,0}{Branch Question17}
A:B280:  '{if @@("F74")>"8"}{BEEP}{Message Msg2,28,13,0}{Branch Question17}
A:A281:  'TheEnd
A:B281:  '{GRAPHVIEW THE_END}
A:A282:  '~
A:B282:  '{GRAPHCHAR A282}
A:B283:  '{if @@("A282")<>"~"}{Branch TheEnd}
A:A284:  'ShowMenu
A:B284:  '{deletemenu /Processing ...}
A:B285:  '{Breakon}
A:B286:  '{APPLICATION.DISPLAY "none,yes,yes,yes,a..b:a1..b2"}
A:B287:  '{setobjectproperty "/File.hidden","no"}
A:B288:  '{setobjectproperty "/EDIT.hidden","no"}
A:B289:  '{setobjectproperty "/BLOCK.hidden","no"}
A:B290:  '{setobjectproperty "/DATA.hidden","no"}
A:B291:  '{setobjectproperty "/TOOLS.hidden","no"}
A:B292:  '{setobjectproperty "/GRAPH.hidden","no"}
A:B293:  '{setobjectproperty "/PROPERTY.hidden","no"}
A:B294:  '{setobjectproperty "/WINDOW.hidden","no"}
A:B295:  '{setobjectproperty "/HELP.hidden","no"}
A:B296:  '{WINDOWshow thesis.wb1}
A:B297:  '{}
A:C297:  '{OPEN "A:\S1_
A:B298:  '{CALC}
A:C298:  @INT(@NOW-34334)
A:B299:  +C297&@STRING(C298,0)&C299
A:C299:  '.txt",w}
A:B300:  '{Writeln "Cor_Ans,",+h31,",",+h32,",",+h33,",",+h34,",",+h35,",",+h36,",",+h37,",",+h38,",",+h38,
         ",",+h39,",",+h40,",",+h41,",",+h42,",",+h43,",",+h44,",",+h45,",",+h46,",",+h47,",",+h48,",",+h49,"
         ,",+h50}
A:C300:  '
A:B301:  '{writeln "Time,",@string(k31,0),",",@string(k32,0),",",@string(k33,0),",",@string(k34,0),",",@str
         ing(k35,0),",",@string(k36,0),",",@string(k37,0),",",@string(k38,0),",",@string(k39,0),",",@strin
         g(k40,0),",",@string(k41,0),",",@string(k42,0),",",@string(k43,0),",",@string(k44,0),",",@string(
         k45,0),",",@string(k46,0),",",@string(k47,0),",",@string(k48,0),",",@string(k49,0),",",@string(k5
         0,0)}
A:C301:  '
A:B302:  '{Writeln "Survey,",+f58,",",+f59,",",+f60,",",+f61,",",+f62,",",+f63,",",+f64,",",+f65,",",+f66,",",+f67
         ,",",+f68,",",+f69,",",+f70,",",+f71,",",+f72,",",+f73,",",+f74}
A:C302:  '
A:B303:  '{Close}
A:B304:  '{Quit}
```

Appendix D. Raw Data

This appendix contains the recorded performance for each question as accomplished by the individual subjects who participated in the experiment. Table 28 contains the accuracy scores that each individual received by mode of presentation and task anchoring level. Table 29 contains the response time scores that each individual received by mode of presentation and task anchoring level. Finally, Table 30 contains each individual's response to the end-of-exercise questionnaire. The questions asked during the end-of-exercise questionnaire are located in Appendix B.

Table 28. Accuracy Scores.

MODE>	Table	Table	Table	Table	2D-Bar	2D-Bar	2D-Bar
TASK>	HH	HL	LH	LL	HH	HL	LH
Subj. 1	0	1	1	1	1	1	1
Subj. 2	1	1	1	1	1	1	1
Subj. 3	1	1	1	1	1	1	1
Subj. 4	1	1	1	0	1	1	1
Subj. 5	1	1	1	1	1	1	1
Subj. 6	1	1	1	1	1	1	1
Subj. 7	1	1	1	0	0	1	1
Subj. 8	1	1	1	1	1	1	1
Subj. 9	1	1	1	1	1	1	1
Subj. 10	1	1	1	0	1	1	1
Subj. 11	1	1	1	0	1	1	1
Subj. 12	1	1	1	0	1	1	1
Subj. 13	0	1	1	1	1	1	1
Subj. 14	1	1	1	1	1	1	1
Subj. 15	1	1	1	1	1	1	1
Subj. 16	1	1	1	1	1	1	1
Subj. 17	1	1	1	1	1	1	1
Subj. 18	1	1	1	1	1	1	1
Subj. 19	1	1	1	1	1	1	1
Subj. 20	1	1	1	0	1	1	1
Subj. 21	1	1	1	1	1	1	1
Subj. 22	1	1	1	0	1	1	1
Subj. 23	1	1	1	1	1	1	1
Subj. 24	0	1	1	1	1	1	1
Subj. 25	1	1	1	0	1	1	1
Subj. 26	1	1	1	1	1	0	1
Subj. 27	1	1	1	1	1	1	1
Subj. 28	1	1	1	1	1	1	1
Subj. 29	1	1	1	1	1	1	1
Subj. 30	1	1	1	0	1	1	1
Subj. 31	1	1	1	1	1	1	1
Subj. 32	0	1	1	1	0	1	1

Table 28. Accuracy Scores (continued).

MODE>	Table	Table	Table	Table	2D-Bar	2D-Bar	2D-Bar
TASK>	HH	HL	LH	LL	HH	HL	LH
Subj. 33	1	1	1	1	1	1	1
Subj. 34	1	1	1	1	1	1	1
Subj. 35	1	1	1	0	0	1	1
Subj. 36	1	1	1	1	1	1	1
Subj. 37	0	1	1	1	1	1	1
Subj. 38	1	1	1	0	1	1	1
Subj. 39	1	1	1	1	1	1	1
Subj. 40	1	1	1	1	1	1	1
Subj. 41	1	1	1	1	1	1	1
Subj. 42	1	1	1	1	1	1	1
Subj. 43	1	1	1	1	1	1	1
Subj. 44	1	1	1	1	1	1	1
Subj. 45	1	1	1	1	1	1	1
Subj. 46	1	1	1	1	1	1	1
Subj. 47	1	1	1	0	1	1	1
Subj. 48	1	1	1	1	1	1	1
Subj. 49	1	1	1	0	0	1	1
Subj. 50	1	1	1	1	1	1	1
Subj. 51	1	1	1	1	1	1	1
Subj. 52	1	1	1	1	0	1	1
Subj. 53	1	1	1	1	1	1	1
Subj. 54	1	1	1	1	1	1	1
Subj. 55	1	1	1	1	1	1	1
Subj. 56	1	1	1	1	1	1	1
Subj. 57	1	1	1	0	1	0	0
Subj. 58	1	1	1	1	1	1	1
Subj. 59	1	1	1	1	1	1	1
Subj. 60	1	1	1	1	1	1	1
Subj. 61	1	1	1	1	1	1	1
Subj. 62	1	1	1	1	0	1	1
Subj. 63	1	1	1	1	1	1	1
Subj. 64	1	1	1	1	1	1	1

Table 28. Accuracy Scores (continued).

MODE>	2D-Bar	3D-Bar	3D-Bar	3D-Bar	3D-Bar	2D-Line	2D-Line
TASK>	LL	HH	HL	LH	LL	HH	HL
Subj. 1	0	1	1	1	1	1	1
Subj. 2	1	1	1	1	1	1	0
Subj. 3	1	1	1	1	1	1	1
Subj. 4	1	1	1	1	1	1	1
Subj. 5	1	1	1	1	1	1	1
Subj. 6	1	0	1	1	0	0	1
Subj. 7	0	1	1	1	1	1	1
Subj. 8	0	1	1	1	1	1	1
Subj. 9	1	1	1	1	1	1	1
Subj. 10	0	1	1	1	0	1	1
Subj. 11	1	1	1	1	1	1	1
Subj. 12	1	1	1	1	1	1	1
Subj. 13	1	0	1	1	1	0	1
Subj. 14	1	1	1	1	1	1	1
Subj. 15	1	1	1	1	1	1	1
Subj. 16	1	1	1	1	1	1	1
Subj. 17	1	1	1	1	1	1	1
Subj. 18	1	1	1	1	1	1	1
Subj. 19	0	1	1	1	1	1	1
Subj. 20	0	1	1	1	0	1	1
Subj. 21	1	0	1	1	1	1	1
Subj. 22	1	1	1	1	0	1	1
Subj. 23	1	1	1	1	1	1	1
Subj. 24	0	1	1	1	0	1	1
Subj. 25	0	1	1	1	1	1	1
Subj. 26	0	1	1	1	1	1	1
Subj. 27	1	1	1	1	0	1	1
Subj. 28	1	1	1	1	0	1	1
Subj. 29	0	1	1	1	1	1	1
Subj. 30	0	1	1	1	1	1	1
Subj. 31	1	1	1	1	1	1	1
Subj. 32	1	0	1	1	1	0	1

Table 28. Accuracy Scores (continued).

MODE>	2D-Bar	3D-Bar	3D-Bar	3D-Bar	3D-Bar	2D-Line	2D-Line
TASK>	LL	HH	HL	LH	LL	HH	HL
Subj. 33	1	1	1	1	1	1	1
Subj. 34	1	1	1	1	1	1	1
Subj. 35	1	1	1	1	1	1	1
Subj. 36	1	1	1	1	0	1	1
Subj. 37	1	1	1	1	1	1	1
Subj. 38	1	1	1	1	1	0	1
Subj. 39	1	1	1	1	0	1	1
Subj. 40	1	1	1	1	1	1	1
Subj. 41	1	1	1	1	1	1	1
Subj. 42	1	1	1	1	0	1	1
Subj. 43	1	1	0	1	0	1	1
Subj. 44	1	1	1	1	1	1	1
Subj. 45	1	0	1	1	0	0	0
Subj. 46	1	0	1	1	1	1	1
Subj. 47	1	1	1	1	1	1	1
Subj. 48	1	1	1	1	0	1	1
Subj. 49	1	1	1	1	1	0	1
Subj. 50	1	1	1	1	1	1	1
Subj. 51	1	1	1	1	0	1	1
Subj. 52	1	1	1	1	0	1	1
Subj. 53	1	1	1	1	1	1	1
Subj. 54	1	0	1	1	1	1	1
Subj. 55	1	1	1	1	1	1	1
Subj. 56	1	1	1	1	1	1	1
Subj. 57	1	1	1	1	1	1	1
Subj. 58	1	1	1	0	1	1	1
Subj. 59	1	1	1	1	1	1	1
Subj. 60	1	1	1	1	1	1	1
Subj. 61	1	0	1	1	1	1	1
Subj. 62	1	1	1	1	0	1	1
Subj. 63	1	1	1	1	0	1	1
Subj. 64	1	1	1	1	0	1	1

Table 28. Accuracy Scores (continued).

MODE>	2D-Line	2D-Line	3D-Line	3D-Line	3D-Line	3D-Line
TASK>	LH	LL	HH	HL	LH	LL
Subj. 1	1	1	0	1	1	1
Subj. 2	1	1	1	1	1	1
Subj. 3	1	1	0	1	1	0
Subj. 4	1	1	0	1	1	1
Subj. 5	1	1	0	1	1	1
Subj. 6	1	1	0	1	1	0
Subj. 7	1	1	0	1	1	0
Subj. 8	1	1	0	1	1	0
Subj. 9	1	1	0	1	1	1
Subj. 10	1	0	0	1	1	0
Subj. 11	1	1	0	1	1	0
Subj. 12	1	1	0	1	1	0
Subj. 13	1	1	1	1	1	1
Subj. 14	1	1	0	1	1	1
Subj. 15	1	1	0	1	1	1
Subj. 16	1	1	0	1	1	0
Subj. 17	1	1	0	1	1	1
Subj. 18	1	1	0	1	0	1
Subj. 19	1	1	0	1	1	0
Subj. 20	1	1	0	1	1	0
Subj. 21	1	1	0	1	1	1
Subj. 22	1	1	0	1	1	1
Subj. 23	1	1	0	1	1	0
Subj. 24	1	0	0	1	1	0
Subj. 25	1	1	0	1	1	1
Subj. 26	1	1	0	1	1	1
Subj. 27	1	1	0	1	1	1
Subj. 28	1	1	0	1	1	1
Subj. 29	1	0	0	1	1	1
Subj. 30	1	1	0	1	1	0
Subj. 31	1	0	0	1	1	0
Subj. 32	0	0	0	1	1	0

Table 28. Accuracy Scores (continued).

MODE>	2D-Line	2D-Line	3D-Line	3D-Line	3D-Line	3D-Line
TASK>	LH	LL	HH	HL	LH	LL
Subj. 33	1	1	0	1	1	0
Subj. 34	1	1	0	1	1	1
Subj. 35	1	1	1	1	1	1
Subj. 36	1	0	0	1	1	0
Subj. 37	1	0	0	1	1	0
Subj. 38	1	0	1	1	1	1
Subj. 39	1	1	1	1	1	1
Subj. 40	1	1	0	1	1	1
Subj. 41	1	1	1	1	1	0
Subj. 42	1	0	0	1	1	1
Subj. 43	1	1	1	0	1	0
Subj. 44	1	1	0	1	1	1
Subj. 45	1	1	0	1	0	0
Subj. 46	1	1	1	1	1	1
Subj. 47	1	1	1	1	1	1
Subj. 48	1	1	0	1	1	0
Subj. 49	1	0	1	1	1	0
Subj. 50	1	0	0	1	1	0
Subj. 51	1	1	1	1	1	1
Subj. 52	1	0	0	1	1	1
Subj. 53	1	1	1	1	1	1
Subj. 54	1	1	1	1	1	1
Subj. 55	1	0	1	1	1	1
Subj. 56	1	1	0	1	1	1
Subj. 57	1	1	0	1	1	1
Subj. 58	1	1	1	1	1	1
Subj. 59	1	1	1	1	1	1
Subj. 60	1	0	0	1	1	1
Subj. 61	1	1	1	1	1	1
Subj. 62	1	1	1	1	1	0
Subj. 63	1	1	1	1	1	0
Subj. 64	1	0	1	1	1	1

Table 29. Response Time.

MODE>	Table	Table	Table	Table	2D-Bar	2D-Bar	2D-Bar
TASK>	HH	HL	LH	LL	HH	HL	LH
Subj. 1	57.0	22.0	32.0	63.0	28.0	12.0	12.0
Subj. 2	15.0	31.0	24.0	52.0	20.0	19.0	11.0
Subj. 3	10.0	12.0	14.0	27.0	10.0	11.0	8.0
Subj. 4	10.0	20.0	9.0	19.0	38.0	9.0	12.0
Subj. 5	13.0	13.0	21.0	37.0	19.0	15.0	17.0
Subj. 6	13.0	16.0	14.0	28.0	21.0	12.0	16.0
Subj. 7	21.0	23.0	43.0	64.0	41.0	35.0	23.0
Subj. 8	9.0	25.0	45.0	62.0	23.0	17.0	14.0
Subj. 9	29.0	25.0	21.0	106.0	53.0	23.0	17.0
Subj. 10	13.0	9.0	17.0	29.0	13.0	12.0	29.0
Subj. 11	14.0	13.0	34.0	94.0	15.0	33.0	15.0
Subj. 12	15.0	12.0	11.0	46.0	15.0	12.0	15.0
Subj. 13	41.0	15.0	28.0	50.0	27.0	17.0	13.0
Subj. 14	17.0	29.0	17.0	36.0	16.0	18.0	37.0
Subj. 15	23.0	21.0	28.0	78.0	14.0	40.0	41.0
Subj. 16	25.0	17.0	33.0	48.0	14.0	16.0	21.0
Subj. 17	17.0	35.0	26.0	57.0	18.0	29.0	17.0
Subj. 18	9.0	11.0	11.0	39.0	9.0	9.0	17.0
Subj. 19	19.0	23.0	43.0	185.0	15.0	21.0	23.0
Subj. 20	16.0	25.0	52.0	74.0	19.0	27.0	17.0
Subj. 21	20.0	16.0	20.0	64.0	16.0	29.0	13.0
Subj. 22	10.0	13.0	17.0	21.0	10.0	15.0	9.0
Subj. 23	10.0	18.0	27.0	65.0	22.0	16.0	26.0
Subj. 24	36.0	25.0	19.0	59.0	13.0	21.0	13.0
Subj. 25	18.0	18.0	39.0	54.0	12.0	18.0	13.0
Subj. 26	13.0	20.0	14.0	51.0	15.0	17.0	17.0
Subj. 27	40.0	18.0	18.0	34.0	18.0	20.0	12.0
Subj. 28	12.0	16.0	13.0	68.0	13.0	14.0	18.0
Subj. 29	13.0	17.0	12.0	33.0	15.0	12.0	13.0
Subj. 30	16.0	24.0	15.0	35.0	24.0	11.0	14.0
Subj. 31	22.0	17.0	22.0	64.0	27.0	18.0	27.0
Subj. 32	19.0	19.0	41.0	36.0	13.0	18.0	18.0

Table 29. Response Time (continued).

MODE>	Table	Table	Table	Table	2D-Bar	2D-Bar	2D-Bar
TASK>	HH	HL	LH	LL	HH	HL	LH
Subj. 33	11.0	23.0	16.0	67.0	18.0	11.0	11.0
Subj. 34	16.0	13.0	12.0	46.0	11.0	10.0	15.0
Subj. 35	20.0	23.0	25.0	16.0	13.0	33.0	23.0
Subj. 36	17.0	20.0	25.0	27.0	12.0	31.0	8.0
Subj. 37	10.0	19.0	25.0	70.0	16.0	28.0	39.0
Subj. 38	27.0	13.0	11.0	54.0	16.0	24.0	14.0
Subj. 39	24.0	14.0	43.0	50.0	23.0	20.0	17.0
Subj. 40	11.0	14.0	9.0	38.0	11.0	15.0	34.0
Subj. 41	12.0	9.0	16.0	17.0	14.0	9.0	12.0
Subj. 42	17.0	16.0	14.0	64.0	11.0	11.0	10.0
Subj. 43	14.0	17.0	11.0	35.0	11.0	12.0	14.0
Subj. 44	15.0	23.0	47.0	33.0	10.0	19.0	29.0
Subj. 45	11.0	32.0	15.0	35.0	14.0	15.0	20.0
Subj. 46	11.0	20.0	28.0	68.0	12.0	16.0	27.0
Subj. 47	14.0	16.0	13.0	43.0	30.0	20.0	22.0
Subj. 48	10.0	12.0	11.0	29.0	10.0	10.0	8.0
Subj. 49	12.0	18.0	11.0	63.0	22.0	15.0	17.0
Subj. 50	21.0	16.0	46.0	26.0	12.0	23.0	18.0
Subj. 51	34.0	16.0	18.0	62.0	19.0	25.0	25.0
Subj. 52	11.0	14.0	21.0	95.0	45.0	16.0	10.0
Subj. 53	27.0	14.0	12.0	44.0	17.0	33.0	21.0
Subj. 54	19.0	16.0	21.0	44.0	65.0	28.0	11.0
Subj. 55	39.0	15.0	29.0	57.0	19.0	16.0	20.0
Subj. 56	11.0	21.0	13.0	60.0	18.0	38.0	24.0
Subj. 57	29.0	19.0	70.0	26.0	21.0	21.0	20.0
Subj. 58	15.0	13.0	11.0	34.0	12.0	25.0	14.0
Subj. 59	15.0	13.0	17.0	21.0	11.0	19.0	19.0
Subj. 60	27.0	27.0	30.0	146.0	14.0	17.0	29.0
Subj. 61	10.0	15.0	11.0	36.0	11.0	16.0	26.0
Subj. 62	21.0	18.0	25.0	82.0	23.0	26.0	19.0
Subj. 63	15.0	18.0	16.0	44.0	18.0	15.0	17.0
Subj. 64	16.0	25.0	19.0	46.0	11.0	21.0	24.0

Table 29. Response Time (continued).

MODE>	2D-Bar	3D-Bar	3D-Bar	3D-Bar	3D-Bar	2D-Line	2D-Line
TASK>	LL	HH	HL	LH	LL	HH	HL
Subj. 1	25.0	15.0	13.0	9.0	40.0	25.0	26.0
Subj. 2	35.0	16.0	24.0	18.0	95.0	15.0	36.0
Subj. 3	22.0	13.0	56.0	12.0	24.0	11.0	14.0
Subj. 4	26.0	12.0	15.0	8.0	21.0	10.0	14.0
Subj. 5	31.0	18.0	57.0	13.0	26.0	16.0	12.0
Subj. 6	30.0	39.0	15.0	18.0	38.0	21.0	17.0
Subj. 7	28.0	16.0	46.0	24.0	97.0	20.0	29.0
Subj. 8	85.0	17.0	14.0	20.0	64.0	15.0	18.0
Subj. 9	102.0	18.0	20.0	28.0	83.0	22.0	14.0
Subj. 10	25.0	10.0	15.0	8.0	15.0	13.0	16.0
Subj. 11	45.0	13.0	25.0	15.0	42.0	8.0	14.0
Subj. 12	24.0	13.0	16.0	19.0	47.0	14.0	31.0
Subj. 13	51.0	17.0	20.0	20.0	28.0	20.0	18.0
Subj. 14	37.0	19.0	23.0	26.0	97.0	26.0	14.0
Subj. 15	80.0	16.0	26.0	28.0	31.0	30.0	28.0
Subj. 16	18.0	15.0	23.0	30.0	65.0	15.0	28.0
Subj. 17	74.0	13.0	22.0	25.0	216.0	87.0	34.0
Subj. 18	34.0	13.0	15.0	9.0	23.0	9.0	12.0
Subj. 19	56.0	38.0	94.0	28.0	31.0	18.0	21.0
Subj. 20	43.0	22.0	26.0	22.0	33.0	39.0	19.0
Subj. 21	29.0	28.0	27.0	14.0	63.0	12.0	13.0
Subj. 22	39.0	17.0	19.0	12.0	63.0	12.0	16.0
Subj. 23	39.0	21.0	18.0	11.0	63.0	17.0	20.0
Subj. 24	10.0	20.0	33.0	23.0	85.0	16.0	19.0
Subj. 25	30.0	20.0	24.0	18.0	46.0	11.0	11.0
Subj. 26	49.0	21.0	23.0	17.0	31.0	16.0	17.0
Subj. 27	47.0	19.0	22.0	28.0	52.0	12.0	18.0
Subj. 28	14.0	36.0	23.0	15.0	27.0	14.0	14.0
Subj. 29	24.0	30.0	18.0	13.0	38.0	22.0	12.0
Subj. 30	20.0	15.0	14.0	9.0	28.0	11.0	20.0
Subj. 31	62.0	29.0	22.0	36.0	63.0	22.0	21.0
Subj. 32	18.0	32.0	18.0	26.0	18.0	20.0	14.0

Table 29. Response Time (continued).

MODE>	2D-Bar	3D-Bar	3D-Bar	3D-Bar	3D-Bar	2D-Line	2D-Line
TASK>	LL	HH	HL	LH	LL	HH	HL
Subj. 33	28.0	16.0	28.0	16.0	43.0	9.0	13.0
Subj. 34	24.0	20.0	13.0	15.0	27.0	14.0	14.0
Subj. 35	44.0	12.0	23.0	13.0	41.0	24.0	33.0
Subj. 36	23.0	40.0	13.0	19.0	15.0	12.0	37.0
Subj. 37	28.0	19.0	63.0	54.0	44.0	38.0	19.0
Subj. 38	42.0	11.0	21.0	11.0	40.0	43.0	18.0
Subj. 39	58.0	10.0	33.0	32.0	48.0	26.0	9.0
Subj. 40	46.0	19.0	12.0	18.0	43.0	16.0	17.0
Subj. 41	40.0	9.0	14.0	20.0	27.0	11.0	10.0
Subj. 42	42.0	16.0	14.0	13.0	39.0	14.0	21.0
Subj. 43	16.0	10.0	22.0	10.0	29.0	15.0	14.0
Subj. 44	35.0	14.0	30.0	15.0	55.0	14.0	29.0
Subj. 45	29.0	25.0	27.0	15.0	35.0	13.0	22.0
Subj. 46	80.0	49.0	14.0	17.0	54.0	10.0	46.0
Subj. 47	66.0	23.0	17.0	26.0	58.0	17.0	24.0
Subj. 48	29.0	15.0	17.0	12.0	21.0	12.0	12.0
Subj. 49	48.0	28.0	22.0	20.0	35.0	8.0	45.0
Subj. 50	70.0	15.0	36.0	17.0	34.0	11.0	14.0
Subj. 51	93.0	9.0	12.0	20.0	52.0	14.0	17.0
Subj. 52	74.0	14.0	24.0	17.0	36.0	42.0	17.0
Subj. 53	43.0	15.0	17.0	19.0	37.0	27.0	18.0
Subj. 54	65.0	58.0	14.0	24.0	37.0	12.0	31.0
Subj. 55	39.0	14.0	26.0	13.0	55.0	16.0	13.0
Subj. 56	66.0	19.0	16.0	11.0	31.0	16.0	29.0
Subj. 57	73.0	22.0	13.0	16.0	37.0	29.0	20.0
Subj. 58	26.0	13.0	12.0	16.0	20.0	8.0	12.0
Subj. 59	17.0	17.0	13.0	22.0	31.0	21.0	16.0
Subj. 60	48.0	18.0	51.0	22.0	72.0	24.0	13.0
Subj. 61	21.0	25.0	13.0	23.0	36.0	19.0	25.0
Subj. 62	67.0	20.0	42.0	25.0	50.0	21.0	15.0
Subj. 63	51.0	18.0	21.0	19.0	34.0	23.0	36.0
Subj. 64	51.0	14.0	28.0	17.0	75.0	18.0	26.0

Table 29. Response Time (continued).

MODE>	2D-Line	2D-Line	3D-Line	3D-Line	3D-Line	3D-Line
TASK>	LH	LL	HH	HL	LH	LL
Subj. 1	10.0	13.0	33.0	17.0	34.0	36.0
Subj. 2	14.0	41.0	16.0	17.0	28.0	56.0
Subj. 3	10.0	23.0	28.0	11.0	15.0	22.0
Subj. 4	15.0	16.0	11.0	11.0	11.0	28.0
Subj. 5	12.0	17.0	25.0	15.0	52.0	17.0
Subj. 6	13.0	34.0	33.0	19.0	8.0	35.0
Subj. 7	35.0	43.0	13.0	29.0	15.0	34.0
Subj. 8	9.0	36.0	30.0	37.0	21.0	56.0
Subj. 9	12.0	35.0	26.0	15.0	24.0	42.0
Subj. 10	12.0	23.0	14.0	15.0	17.0	10.0
Subj. 11	15.0	59.0	18.0	12.0	16.0	57.0
Subj. 12	12.0	18.0	30.0	20.0	18.0	46.0
Subj. 13	20.0	33.0	33.0	12.0	85.0	11.0
Subj. 14	17.0	26.0	39.0	12.0	19.0	41.0
Subj. 15	17.0	51.0	36.0	16.0	56.0	65.0
Subj. 16	9.0	40.0	47.0	16.0	19.0	25.0
Subj. 17	15.0	44.0	36.0	13.0	56.0	12.0
Subj. 18	11.0	23.0	19.0	15.0	26.0	19.0
Subj. 19	17.0	148.0	43.0	26.0	39.0	47.0
Subj. 20	15.0	15.0	36.0	28.0	25.0	27.0
Subj. 21	15.0	20.0	21.0	16.0	23.0	14.0
Subj. 22	12.0	26.0	20.0	10.0	16.0	11.0
Subj. 23	14.0	28.0	37.0	13.0	14.0	33.0
Subj. 24	14.0	27.0	14.0	30.0	21.0	19.0
Subj. 25	37.0	21.0	34.0	16.0	13.0	22.0
Subj. 26	11.0	28.0	26.0	20.0	26.0	20.0
Subj. 27	14.0	49.0	43.0	14.0	16.0	41.0
Subj. 28	12.0	44.0	31.0	15.0	14.0	32.0
Subj. 29	11.0	28.0	25.0	15.0	23.0	20.0
Subj. 30	11.0	14.0	15.0	12.0	36.0	13.0
Subj. 31	25.0	54.0	29.0	15.0	17.0	28.0
Subj. 32	14.0	34.0	26.0	13.0	21.0	20.0

Table 29. Response Time (continued).

MODE>	2D-Line	2D-Line	3D-Line	3D-Line	3D-Line	3D-Line
TASK>	LH	LL	HH	HL	LH	LL
Subj. 33	13.0	24.0	34.0	15.0	15.0	25.0
Subj. 34	23.0	39.0	32.0	18.0	34.0	22.0
Subj. 35	13.0	19.0	16.0	13.0	17.0	40.0
Subj. 36	97.0	18.0	22.0	10.0	25.0	32.0
Subj. 37	38.0	39.0	18.0	21.0	18.0	61.0
Subj. 38	48.0	26.0	39.0	12.0	23.0	16.0
Subj. 39	11.0	47.0	32.0	10.0	30.0	34.0
Subj. 40	32.0	40.0	23.0	23.0	25.0	32.0
Subj. 41	10.0	36.0	17.0	12.0	11.0	16.0
Subj. 42	7.0	17.0	16.0	10.0	20.0	19.0
Subj. 43	16.0	25.0	26.0	12.0	15.0	16.0
Subj. 44	14.0	61.0	23.0	32.0	16.0	71.0
Subj. 45	19.0	42.0	23.0	15.0	24.0	21.0
Subj. 46	16.0	75.0	47.0	18.0	27.0	64.0
Subj. 47	34.0	38.0	40.0	34.0	14.0	70.0
Subj. 48	13.0	26.0	20.0	10.0	10.0	18.0
Subj. 49	15.0	24.0	23.0	21.0	26.0	23.0
Subj. 50	14.0	36.0	21.0	15.0	26.0	15.0
Subj. 51	30.0	31.0	31.0	10.0	22.0	23.0
Subj. 52	28.0	59.0	14.0	15.0	21.0	136.0
Subj. 53	35.0	28.0	72.0	17.0	15.0	44.0
Subj. 54	15.0	72.0	29.0	13.0	23.0	47.0
Subj. 55	18.0	25.0	35.0	16.0	14.0	27.0
Subj. 56	17.0	62.0	27.0	11.0	22.0	47.0
Subj. 57	29.0	23.0	17.0	23.0	13.0	37.0
Subj. 58	14.0	23.0	18.0	11.0	17.0	38.0
Subj. 59	38.0	21.0	25.0	12.0	11.0	22.0
Subj. 60	57.0	29.0	48.0	37.0	14.0	20.0
Subj. 61	10.0	23.0	34.0	14.0	13.0	31.0
Subj. 62	34.0	38.0	28.0	19.0	17.0	53.0
Subj. 63	27.0	43.0	29.0	22.0	23.0	38.0
Subj. 64	82.0	49.0	17.0	17.0	14.0	20.0

Table 30. Questionnaire Responses.

Question>	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9
Subj. 1	5	3	3	5	5	3	4	2	3
Subj. 2	5	2	3	2	6	3	6	2	7
Subj. 3	5	1	4	4	6	1	5	2	4
Subj. 4	3	2	2	4	7	2	5	2	4
Subj. 5	2	3	3	1	7	3	7	2	5
Subj. 6	5	2	2	6	7	2	4	2	4
Subj. 7	6	2	3	5	5	2	5	2	6
Subj. 8	6	3	2	2	6	6	5	2	3
Subj. 9	7	2	2	5	7	2	7	2	4
Subj. 10	6	1	2	6	6	2	7	2	2
Subj. 11	6	4	4	3	7	6	6	2	3
Subj. 12	6	5	2	1	6	2	7	2	4
Subj. 13	4	4	4	4	6	4	6	2	4
Subj. 14	6	3	3	1	7	3	7	2	5
Subj. 15	6	2	2	3	6	2	5	2	6
Subj. 16	7	2	2	3	7	2	6	2	6
Subj. 17	5	3	2	2	6	3	6	2	5
Subj. 18	6	5	5	2	6	3	5	1	4
Subj. 19	6	2	2	3	6	2	6	2	6
Subj. 20	6	2	2	2	6	2	4	2	7
Subj. 21	6	2	2	1	7	2	5	2	7
Subj. 22	5	1	2	3	7	2	6	2	6
Subj. 23	3	1	2	2	6	1	6	2	3
Subj. 24	1	4	4	1	1	4	7	2	6
Subj. 25	5	2	2	3	6	2	5	2	3
Subj. 26	5	3	2	5	7	2	6	2	3
Subj. 27	7	2	3	2	7	3	6	2	7
Subj. 28	6	2	2	2	7	2	6	2	6
Subj. 29	6	2	2	2	7	2	5	2	4
Subj. 30	6	2	3	5	5	2	6	2	3
Subj. 31	4	2	4	3	7	3	6	2	5
Subj. 32	3	2	2	5	7	2	4	2	7

Table 30. Questionnaire Responses (continued).

Question>	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9
Subj. 33	6	2	1	3	6	2	5	2	5
Subj. 34	6	3	2	1	7	2	6	2	4
Subj. 35	7	5	2	4	7	2	4	2	6
Subj. 36	6	1	3	1	7	1	7	2	4
Subj. 37	6	2	2	2	6	1	5	2	8
Subj. 38	5	1	3	4	4	2	5	2	7
Subj. 39	6	1	2	2	6	2	7	2	1
Subj. 40	5	1	1	1	6	1	5	2	7
Subj. 41	7	2	2	1	7	2	6	2	4
Subj. 42	1	2	2	1	7	2	6	2	6
Subj. 43	4	3	3	1	7	3	4	2	3
Subj. 44	4	1	1	4	6	1	4	2	6
Subj. 45	2	1	2	3	6	1	6	2	8
Subj. 46	2	1	1	1	1	1	5	2	7
Subj. 47	5	1	1	2	6	1	7	2	8
Subj. 48	6	2	2	2	7	2	6	2	5
Subj. 49	4	2	2	4	6	2	4	2	6
Subj. 50	5	2	2	3	6	2	4	2	7
Subj. 51	5	2	3	4	7	3	6	2	7
Subj. 52	6	1	3	4	4	3	5	2	7
Subj. 53	5	3	3	4	6	3	4	2	6
Subj. 54	7	3	3	5	7	3	5	2	3
Subj. 55	7	2	2	3	7	2	5	2	7
Subj. 56	6	2	1	1	7	2	6	1	6
Subj. 57	6	3	1	1	6	3	6	2	3
Subj. 58	7	1	2	2	7	1	5	2	6
Subj. 59	6	1	2	4	7	2	6	2	6
Subj. 60	4	2	2	6	7	2	7	2	8
Subj. 61	7	4	4	4	7	4	2	2	4
Subj. 62	6	3	2	3	6	2	5	2	3
Subj. 63	4	4	1	4	4	4	2	2	7
Subj. 64	7	2	3	2	6	3	5	2	4

Table 30. Questionnaire Responses (continued).

Question>	Q 10	Q 11	Q 12	Q 13	Q 14	Q 15	Q 16	Q 17
Subj. 1	3	3	1	8	6	5	2	2
Subj. 2	3	7	1	3	4	1	8	2
Subj. 3	6	6	1	2	6	5	2	8
Subj. 4	6	6	1	8	6	3	4	2
Subj. 5	2	3	1	3	4	8	7	2
Subj. 6	3	5	1	2	6	2	8	8
Subj. 7	4	4	2	2	4	5	3	2
Subj. 8	7	3	1	9	6	6	6	2
Subj. 9	3	4	1	8	6	5	4	2
Subj. 10	1	1	1	2	4	6	4	2
Subj. 11	6	3	1	3	5	4	4	7
Subj. 12	6	6	1	2	4	5	3	2
Subj. 13	3	5	1	3	6	3	5	7
Subj. 14	3	5	1	3	6	5	6	2
Subj. 15	7	8	1	2	4	1	3	2
Subj. 16	7	6	2	2	2	1	4	7
Subj. 17	6	3	1	9	6	4	5	2
Subj. 18	7	7	1	8	6	2	5	4
Subj. 19	6	5	1	8	6	5	2	7
Subj. 20	4	7	1	8	5	5	2	2
Subj. 21	7	6	1	8	5	3	3	4
Subj. 22	7	4	2	2	5	5	3	2
Subj. 23	7	6	1	2	4	5	3	2
Subj. 24	1	6	2	2	4	5	4	8
Subj. 25	6	3	1	8	5	3	1	4
Subj. 26	6	4	2	8	6	5	4	2
Subj. 27	6	3	1	8	6	1	2	2
Subj. 28	6	6	2	8	5	3	5	4
Subj. 29	7	5	1	8	5	3	3	4
Subj. 30	6	3	1	2	5	6	5	8
Subj. 31	5	6	1	2	4	5	5	8
Subj. 32	7	6	1	3	4	6	8	8

Table 30. Questionnaire Responses (continued).

Question>	Q 10	Q 11	Q 12	Q 13	Q 14	Q 15	Q 16	Q 17
Subj. 33	1	6	1	8	6	1	7	4
Subj. 34	7	4	1	8	4	5	2	7
Subj. 35	5	8	2	3	5	6	3	2
Subj. 36	3	4	2	2	4	5	5	2
Subj. 37	7	7	2	2	3	1	8	2
Subj. 38	7	6	1	2	2	1	6	8
Subj. 39	7	2	1	8	4	1	2	2
Subj. 40	3	4	2	2	4	5	2	8
Subj. 41	3	4	1	8	6	2	3	2
Subj. 42	1	3	1	2	6	5	4	2
Subj. 43	3	4	1	9	6	4	6	2
Subj. 44	7	8	1	2	6	5	4	8
Subj. 45	3	8	2	1	4	5	4	8
Subj. 46	7	6	2	2	3	5	5	2
Subj. 47	3	4	1	9	6	1	6	2
Subj. 48	7	6	1	3	6	1	6	2
Subj. 49	4	6	2	2	4	5	4	2
Subj. 50	7	7	2	9	6	6	6	2
Subj. 51	6	7	1	8	5	5	5	2
Subj. 52	7	7	1	8	5	3	2	4
Subj. 53	7	6	1	2	6	7	6	8
Subj. 54	4	6	1	8	5	3	3	2
Subj. 55	2	7	1	2	4	5	8	8
Subj. 56	6	3	1	3	6	3	4	8
Subj. 57	7	3	1	2	5	1	8	2
Subj. 58	1	6	1	8	6	5	2	2
Subj. 59	1	6	1	3	4	1	3	2
Subj. 60	3	8	1	2	3	3	6	2
Subj. 61	7	4	1	8	4	3	2	2
Subj. 62	7	8	1	2	3	4	6	2
Subj. 63	7	5	1	2	4	5	4	8
Subj. 64	7	7	1	2	2	8	8	2

Appendix E. LN Transformation of Response Times

This appendix contains the LN transformation of response time score that each individual received by mode of presentation and task anchoring level. In addition, it also contains the demographic categories for gender, rank, educational level, and training level, that each individual was determined to be in based on their responses to the end-of-exercise questions. The data in this appendix was used to perform the Multifactor Analysis of Variance with Repeated Measure calculations provided in Appendix G.

Table 31. LN Transformation of Response Time for Statistical Analyses.

Subject	Data	Gender	Rank	Educ.	Mode> Task> Train.	Table HH	Table HL	Table LH	Table LL
Subj. 1	1	1	1	2	1	2.7	3.1	3.5	4.1
Subj. 2	1	1	2	1	1	3.7	3.4	3.2	4.0
Subj. 3	1	1	1	2	2	2.3	2.5	2.6	3.3
Subj. 4	1	1	1	2	2	2.3	3.0	2.2	2.9
Subj. 5	1	1	2	1	1	2.6	2.6	3.0	3.6
Subj. 6	1	1	1	2	1	2.6	2.8	2.6	3.3
Subj. 7	1	2	1	1	2	3.0	3.1	3.8	4.2
Subj. 8	1	1	2	2	3	2.2	3.2	3.8	4.1
Subj. 9	1	1	1	2	1	3.4	3.2	3.0	4.7
Subj. 10	1	1	1	1	1	2.6	2.2	2.8	3.4
Subj. 11	1	1	2	2	2	2.6	2.6	3.5	4.5
Subj. 12	1	1	1	1	2	2.7	2.5	2.4	3.8
Subj. 13	1	1	2	2	1	3.7	2.7	3.3	3.9
Subj. 14	1	1	2	2	1	2.8	3.4	2.8	3.6
Subj. 15	1	1	1	1	3	3.1	3.0	3.3	4.4
Subj. 16	1	2	1	1	3	3.2	2.8	3.5	3.9
Subj. 17	1	1	1	2	3	2.2	2.4	2.4	3.7
Subj. 18	1	1	1	2	2	2.9	3.1	3.8	5.2
Subj. 19	1	1	1	2	3	3.0	2.8	3.0	4.2
Subj. 20	1	2	1	2	3	2.3	2.6	2.8	3.0
Subj. 21	1	1	1	1	3	2.3	2.9	3.3	4.2
Subj. 22	1	2	1	1	1	3.6	3.2	2.9	4.1
Subj. 23	1	1	1	2	2	2.9	2.9	3.7	4.0
Subj. 24	1	2	1	2	2	2.6	3.0	2.6	3.9
Subj. 25	1	1	1	2	2	3.7	2.9	2.9	3.5
Subj. 26	1	2	1	2	2	2.5	2.8	2.6	4.2
Subj. 27	1	1	1	2	3	2.6	2.8	2.5	3.5
Subj. 28	1	1	1	2	2	2.8	3.2	2.7	3.6
Subj. 29	1	1	1	1	2	3.1	2.8	3.1	4.2
Subj. 30	1	1	2	1	3	2.9	2.9	3.7	3.6
Subj. 31	1	1	1	2	1	2.4	3.1	2.8	4.2

Table 31. LN Transformation of Response Time for Statistical Analyses (continued).

Subject	Data	Gender	Rank	Educ.	Mode> Task> Train.	Table HH	Table HL	Table LH	Table LL
Subj. 32	2	1	1	1	3	2.8	2.6	2.5	3.8
Subj. 33	2	2	2	2	2	3.0	3.1	3.2	2.8
Subj. 34	2	2	1	1	1	2.8	3.0	3.2	3.3
Subj. 35	2	2	1	1	3	2.3	2.9	3.2	4.2
Subj. 36	2	1	1	1	3	3.3	2.5	2.4	4.0
Subj. 37	2	1	1	1	3	3.2	2.6	3.8	3.9
Subj. 38	2	2	1	1	1	2.4	2.6	2.2	3.6
Subj. 39	2	1	1	2	1	2.5	2.2	2.8	2.8
Subj. 40	2	1	1	2	1	2.8	2.8	2.6	4.2
Subj. 41	2	1	2	2	1	2.6	2.8	2.4	3.6
Subj. 42	2	1	1	2	3	2.7	3.1	3.9	3.5
Subj. 43	2	2	1	1	1	2.4	3.5	2.7	3.6
Subj. 44	2	2	1	1	3	2.4	3.0	3.3	4.2
Subj. 45	2	1	2	2	1	2.6	2.8	2.6	3.8
Subj. 46	2	1	2	2	3	2.3	2.5	2.4	3.4
Subj. 47	2	2	1	1	2	2.5	2.9	2.4	4.1
Subj. 48	2	2	2	2	3	3.0	2.8	3.8	3.3
Subj. 49	2	1	1	2	2	3.5	2.8	2.9	4.1
Subj. 50	2	1	1	2	3	2.4	2.6	3.0	4.6
Subj. 51	2	1	1	2	3	3.3	2.6	2.5	3.8
Subj. 52	2	1	1	2	2	2.9	2.8	3.0	3.8
Subj. 53	2	1	1	1	1	3.7	2.7	3.4	4.0
Subj. 54	2	1	2	2	2	2.4	3.0	2.6	4.1
Subj. 55	2	1	1	2	3	3.4	2.9	4.2	3.3
Subj. 56	2	1	1	2	1	2.7	2.6	2.4	3.5
Subj. 57	2	1	2	1	1	2.7	2.6	2.8	3.0
Subj. 58	2	1	1	1	1	3.3	3.3	3.4	5.0
Subj. 59	2	1	1	1	3	2.3	2.7	2.4	3.6
Subj. 60	2	1	1	1	3	3.0	2.9	3.2	4.4
Subj. 61	2	1	1	1	3	2.7	2.9	2.8	3.8
Subj. 62	2	1	1	1	3	2.8	3.2	2.9	3.8

Table 31. LN Transformation of Response Time for Statistical Analyses (continued).

Subject	Data	Gender	Rank	Educ.	Mode> Task> Train.	2D-Bar HH	2D-Bar HL	2D-Bar LH	2D-Bar LL
Subj. 1	1	1	1	2	1	3.3	2.5	2.5	3.2
Subj. 2	1	1	2	1	1	3.0	2.9	2.4	3.6
Subj. 3	1	1	1	2	2	2.3	2.4	2.1	3.1
Subj. 4	1	1	1	2	2	3.6	2.2	2.5	3.3
Subj. 5	1	1	2	1	1	2.9	2.7	2.8	3.4
Subj. 6	1	1	1	2	1	3.0	2.5	2.8	3.4
Subj. 7	1	2	1	1	2	3.7	3.6	3.1	3.3
Subj. 8	1	1	2	2	3	3.1	2.8	2.6	4.4
Subj. 9	1	1	1	2	1	4.0	3.1	2.8	4.6
Subj. 10	1	1	1	1	1	2.6	2.5	3.4	3.2
Subj. 11	1	1	2	2	2	2.7	3.5	2.7	3.8
Subj. 12	1	1	1	1	2	2.7	2.5	2.7	3.2
Subj. 13	1	1	2	2	1	3.3	2.8	2.6	3.9
Subj. 14	1	1	2	2	1	2.8	2.9	3.6	3.6
Subj. 15	1	1	1	1	3	2.6	3.7	3.7	4.4
Subj. 16	1	2	1	1	3	2.6	2.8	3.0	2.9
Subj. 17	1	1	1	2	3	2.2	2.2	2.8	3.5
Subj. 18	1	1	1	2	2	2.7	3.0	3.1	4.0
Subj. 19	1	1	1	2	3	2.8	3.4	2.6	3.4
Subj. 20	1	2	1	2	3	2.3	2.7	2.2	3.7
Subj. 21	1	1	1	1	3	3.1	2.8	3.3	3.7
Subj. 22	1	2	1	1	1	2.6	3.0	2.6	2.3
Subj. 23	1	1	1	2	2	2.5	2.9	2.6	3.4
Subj. 24	1	2	1	2	2	2.7	2.8	2.8	3.9
Subj. 25	1	1	1	2	2	2.9	3.0	2.5	3.9
Subj. 26	1	2	1	2	2	2.6	2.6	2.9	2.6
Subj. 27	1	1	1	2	3	2.7	2.5	2.6	3.2
Subj. 28	1	1	1	2	2	3.2	2.4	2.6	3.0
Subj. 29	1	1	1	1	2	3.3	2.9	3.3	4.1
Subj. 30	1	1	2	1	3	2.6	2.9	2.9	2.9
Subj. 31	1	1	1	2	1	2.9	2.4	2.4	3.3

Table 31. LN Transformation of Response Time for Statistical Analyses (continued).

Subject	Data	Gender	Rank	Educ.	Mode> / Task> / Train.	2D-Bar HH	2D-Bar HL	2D-Bar LH	2D-Bar LL
Subj. 32	2	1	1	1	3	2.4	2.3	2.7	3.2
Subj. 33	2	2	2	2	2	2.6	3.5	3.1	3.8
Subj. 34	2	2	1	1	1	2.5	3.4	2.1	3.1
Subj. 35	2	2	1	1	3	2.8	3.3	3.7	3.3
Subj. 36	2	1	1	1	3	2.8	3.2	2.6	3.7
Subj. 37	2	1	1	1	3	3.1	3.0	2.8	4.1
Subj. 38	2	2	1	1	1	2.4	2.7	3.5	3.8
Subj. 39	2	1	1	2	1	2.6	2.2	2.5	3.7
Subj. 40	2	1	1	2	1	2.4	2.4	2.3	3.7
Subj. 41	2	1	2	2	1	2.4	2.5	2.6	2.8
Subj. 42	2	1	1	2	3	2.3	2.9	3.4	3.6
Subj. 43	2	2	1	1	1	2.6	2.7	3.0	3.4
Subj. 44	2	2	1	1	3	2.5	2.8	3.3	4.4
Subj. 45	2	1	2	2	1	3.4	3.0	3.1	4.2
Subj. 46	2	1	2	2	3	2.3	2.3	2.1	3.4
Subj. 47	2	2	1	1	2	3.1	2.7	2.8	3.9
Subj. 48	2	2	2	2	3	2.5	3.1	2.9	4.2
Subj. 49	2	1	1	2	2	2.9	3.2	3.2	4.5
Subj. 50	2	1	1	2	3	3.8	2.8	2.3	4.3
Subj. 51	2	1	1	2	3	2.8	3.5	3.0	3.8
Subj. 52	2	1	1	2	2	4.2	3.3	2.4	4.2
Subj. 53	2	1	1	1	1	2.9	2.8	3.0	3.7
Subj. 54	2	1	2	2	2	2.9	3.6	3.2	4.2
Subj. 55	2	1	1	2	3	3.0	3.0	3.0	4.3
Subj. 56	2	1	1	2	1	2.5	3.2	2.6	3.3
Subj. 57	2	1	2	1	1	2.4	2.9	2.9	2.8
Subj. 58	2	1	1	1	1	2.6	2.8	3.4	3.9
Subj. 59	2	1	1	1	3	2.4	2.8	3.3	3.0
Subj. 60	2	1	1	1	3	3.1	3.3	2.9	4.2
Subj. 61	2	1	1	1	3	2.9	2.7	2.8	3.9
Subj. 62	2	1	1	1	3	2.4	3.0	3.2	3.9

Table 31. LN Transformation of Response Time for Statistical Analyses (continued).

Subject	Data	Gender	Rank	Educ.	Mode> Task> Train.	3D-Bar HH	3D-Bar HL	3D-Bar LH	3D-Bar LL
Subj. 1	1	1	1	2	1	2.7	2.6	2.2	3.7
Subj. 2	1	1	2	1	1	2.8	3.2	2.9	4.6
Subj. 3	1	1	1	2	2	2.6	4.0	2.5	3.2
Subj. 4	1	1	1	2	2	2.5	2.7	2.1	3.0
Subj. 5	1	1	2	1	1	2.9	4.0	2.6	3.3
Subj. 6	1	1	1	2	1	3.7	2.7	2.9	3.6
Subj. 7	1	2	1	1	2	2.8	3.8	3.2	4.6
Subj. 8	1	1	2	2	3	2.8	2.6	3.0	4.2
Subj. 9	1	1	1	2	1	2.9	3.0	3.3	4.4
Subj. 10	1	1	1	1	1	2.3	2.7	2.1	2.7
Subj. 11	1	1	2	2	2	2.6	3.2	2.7	3.7
Subj. 12	1	1	1	1	2	2.6	2.8	2.9	3.9
Subj. 13	1	1	2	2	1	2.8	3.0	3.0	3.3
Subj. 14	1	1	2	2	1	2.9	3.1	3.3	4.6
Subj. 15	1	1	1	1	3	2.8	3.3	3.3	3.4
Subj. 16	1	2	1	1	3	2.7	3.1	3.4	4.2
Subj. 17	1	1	1	2	3	2.6	2.7	2.2	3.1
Subj. 18	1	1	1	2	2	3.6	4.5	3.3	3.4
Subj. 19	1	1	1	2	3	3.3	3.3	2.6	4.1
Subj. 20	1	2	1	2	3	2.8	2.9	2.5	4.1
Subj. 21	1	1	1	1	3	3.0	2.9	2.4	4.1
Subj. 22	1	2	1	1	1	3.0	3.5	3.1	4.4
Subj. 23	1	1	1	2	2	3.0	3.2	2.9	3.8
Subj. 24	1	2	1	2	2	3.0	3.1	2.8	3.4
Subj. 25	1	1	1	2	2	2.9	3.1	3.3	4.0
Subj. 26	1	2	1	2	2	3.6	3.1	2.7	3.3
Subj. 27	1	1	1	2	3	3.4	2.9	2.6	3.6
Subj. 28	1	1	1	2	2	2.7	2.6	2.2	3.3
Subj. 29	1	1	1	1	2	3.4	3.1	3.6	4.1
Subj. 30	1	1	2	1	3	3.5	2.9	3.3	2.9
Subj. 31	1	1	1	2	1	2.8	3.3	2.8	3.8

Table 31. LN Transformation of Response Time for Statistical Analyses (continued).

Subject	Data	Gender	Rank	Educ.	Mode>	3D-Bar	3D-Bar	3D-Bar	3D-Bar
					Task>	HH	HL	LH	LL
					Train.				
Subj. 32	2	1	1	1	3	3.0	2.6	2.7	3.3
Subj. 33	2	2	2	2	2	2.5	3.1	2.6	3.7
Subj. 34	2	2	1	1	1	3.7	2.6	2.9	2.7
Subj. 35	2	2	1	1	3	2.9	4.1	4.0	3.8
Subj. 36	2	1	1	1	3	2.4	3.0	2.4	3.7
Subj. 37	2	1	1	1	3	2.3	3.5	3.5	3.9
Subj. 38	2	2	1	1	1	2.9	2.5	2.9	3.8
Subj. 39	2	1	1	2	1	2.2	2.6	3.0	3.3
Subj. 40	2	1	1	2	1	2.8	2.6	2.6	3.7
Subj. 41	2	1	2	2	1	2.3	3.1	2.3	3.4
Subj. 42	2	1	1	2	3	2.6	3.4	2.7	4.0
Subj. 43	2	2	1	1	1	3.2	3.3	2.7	3.6
Subj. 44	2	2	1	1	3	3.9	2.6	2.8	4.0
Subj. 45	2	1	2	2	1	3.1	2.8	3.3	4.1
Subj. 46	2	1	2	2	3	2.7	2.8	2.5	3.0
Subj. 47	2	2	1	1	2	3.3	3.1	3.0	3.6
Subj. 48	2	2	2	2	3	2.7	3.6	2.8	3.5
Subj. 49	2	1	1	2	2	2.2	2.5	3.0	4.0
Subj. 50	2	1	1	2	3	2.6	3.2	2.8	3.6
Subj. 51	2	1	1	2	3	2.7	2.8	2.9	3.6
Subj. 52	2	1	1	2	2	4.1	2.6	3.2	3.6
Subj. 53	2	1	1	1	1	2.6	3.3	2.6	4.0
Subj. 54	2	1	2	2	2	2.9	2.8	2.4	3.4
Subj. 55	2	1	1	2	3	3.1	2.6	2.8	3.6
Subj. 56	2	1	1	2	1	2.6	2.5	2.8	3.0
Subj. 57	2	1	2	1	1	2.8	2.6	3.1	3.4
Subj. 58	2	1	1	1	1	2.9	3.9	3.1	4.3
Subj. 59	2	1	1	1	3	3.2	2.6	3.1	3.6
Subj. 60	2	1	1	1	3	3.0	3.7	3.2	3.9
Subj. 61	2	1	1	1	3	2.9	3.0	2.9	3.5
Subj. 62	2	1	1	1	3	2.6	3.3	2.8	4.3

Table 31. LN Transformation of Response Time for Statistical Analyses (continued).

Subject	Data	Gender	Rank	Educ.	Mode> / Task> / Train.	2D-Line HH	2D-Line HL	2D-Line LH	2D-Line LL
Subj. 1	1	1	1	2	1	3.2	3.3	2.3	2.6
Subj. 2	1	1	2	1	1	2.7	3.6	2.6	3.7
Subj. 3	1	1	1	2	2	2.4	2.6	2.3	3.1
Subj. 4	1	1	1	2	2	2.3	2.6	2.7	2.8
Subj. 5	1	1	2	1	1	2.8	2.5	2.5	2.8
Subj. 6	1	1	1	2	1	3.0	2.8	2.6	3.5
Subj. 7	1	2	1	1	2	3.0	3.4	3.6	3.8
Subj. 8	1	1	2	2	3	2.7	2.9	2.2	3.6
Subj. 9	1	1	1	2	1	3.1	2.6	2.5	3.6
Subj. 10	1	1	1	1	1	2.6	2.8	2.5	3.1
Subj. 11	1	1	2	2	2	2.1	2.6	2.7	4.1
Subj. 12	1	1	1	1	2	2.6	3.4	2.5	2.9
Subj. 13	1	1	2	2	1	3.0	2.9	3.0	3.5
Subj. 14	1	1	2	2	1	3.3	2.6	2.8	3.3
Subj. 15	1	1	1	1	3	3.4	3.3	2.8	3.9
Subj. 16	1	2	1	1	3	2.7	3.3	2.2	3.7
Subj. 17	1	1	1	2	3	2.2	2.5	2.4	3.1
Subj. 18	1	1	1	2	2	2.9	3.0	2.8	5.0
Subj. 19	1	1	1	2	3	2.5	2.6	2.7	3.0
Subj. 20	1	2	1	2	3	2.5	2.8	2.5	3.3
Subj. 21	1	1	1	1	3	2.8	3.0	2.6	3.3
Subj. 22	1	2	1	1	1	2.8	2.9	2.6	3.3
Subj. 23	1	1	1	2	2	2.4	2.4	3.6	3.0
Subj. 24	1	2	1	2	2	2.8	2.8	2.4	3.3
Subj. 25	1	1	1	2	2	2.5	2.9	2.6	3.9
Subj. 26	1	2	1	2	2	2.6	2.6	2.5	3.8
Subj. 27	1	1	1	2	3	3.1	2.5	2.4	3.3
Subj. 28	1	1	1	2	2	2.4	3.0	2.4	2.6
Subj. 29	1	1	1	1	2	3.1	3.0	3.2	4.0
Subj. 30	1	1	2	1	3	3.0	2.6	2.6	3.5
Subj. 31	1	1	1	2	1	2.2	2.6	2.6	3.2

Table 31. LN Transformation of Response Time for Statistical Analyses (continued).

Subject	Data	Gender	Rank	Educ.	Mode> Task> Train.	2D-Line HH	2D-Line HL	2D-Line LH	2D-Line LL
Subj. 32	2	1	1	1	3	2.6	2.6	3.1	3.7
Subj. 33	2	2	2	2	2	3.2	3.5	2.6	2.9
Subj. 34	2	2	1	1	1	2.5	3.6	4.6	2.9
Subj. 35	2	2	1	1	3	3.6	2.9	3.6	3.7
Subj. 36	2	1	1	1	3	3.8	2.9	3.9	3.3
Subj. 37	2	1	1	1	3	3.3	2.2	2.4	3.9
Subj. 38	2	2	1	1	1	2.8	2.8	3.5	3.7
Subj. 39	2	1	1	2	1	2.4	2.3	2.3	3.6
Subj. 40	2	1	1	2	1	2.6	3.0	1.9	2.8
Subj. 41	2	1	2	2	1	2.7	2.6	2.8	3.2
Subj. 42	2	1	1	2	3	2.6	3.4	2.6	4.1
Subj. 43	2	2	1	1	1	2.6	3.1	2.9	3.7
Subj. 44	2	2	1	1	3	2.3	3.8	2.8	4.3
Subj. 45	2	1	2	2	1	2.8	3.2	3.5	3.6
Subj. 46	2	1	2	2	3	2.5	2.5	2.6	3.3
Subj. 47	2	2	1	1	2	2.1	3.8	2.7	3.2
Subj. 48	2	2	2	2	3	2.4	2.6	2.6	3.6
Subj. 49	2	1	1	2	2	2.6	2.8	3.4	3.4
Subj. 50	2	1	1	2	3	3.7	2.8	3.3	4.1
Subj. 51	2	1	1	2	3	3.3	2.9	3.6	3.3
Subj. 52	2	1	1	2	2	2.5	3.4	2.7	4.3
Subj. 53	2	1	1	1	1	2.8	2.6	2.9	3.2
Subj. 54	2	1	2	2	2	2.8	3.4	2.8	4.1
Subj. 55	2	1	1	2	3	3.4	3.0	3.4	3.1
Subj. 56	2	1	1	2	1	2.1	2.5	2.6	3.1
Subj. 57	2	1	2	1	1	3.0	2.8	3.6	3.0
Subj. 58	2	1	1	1	1	3.2	2.6	4.0	3.4
Subj. 59	2	1	1	1	3	2.9	3.2	2.3	3.1
Subj. 60	2	1	1	1	3	3.0	2.7	3.5	3.6
Subj. 61	2	1	1	1	3	3.1	3.6	3.3	3.8
Subj. 62	2	1	1	1	3	2.9	3.3	4.4	3.9

Table 31. LN Transformation of Response Time for Statistical Analyses (continued).

Subject	Data	Gender	Rank	Educ.	Mode>	3D-Line	3D-Line	3D-Line	3D-Line
					Task>	HH	HL	LH	LL
					Train.				
Subj. 1	1	1	1	2	1	3.5	2.8	3.5	3.6
Subj. 2	1	1	2	1	1	2.8	2.8	3.3	4.0
Subj. 3	1	1	1	2	2	3.3	2.4	2.7	3.1
Subj. 4	1	1	1	2	2	2.4	2.4	2.4	3.3
Subj. 5	1	1	2	1	1	3.2	2.7	4.0	2.8
Subj. 6	1	1	1	2	1	3.5	2.9	2.1	3.6
Subj. 7	1	2	1	1	2	2.6	3.4	2.7	3.5
Subj. 8	1	1	2	2	3	3.4	3.6	3.0	4.0
Subj. 9	1	1	1	2	1	3.3	2.7	3.2	3.7
Subj. 10	1	1	1	1	1	2.6	2.7	2.8	2.3
Subj. 11	1	1	2	2	2	2.9	2.5	2.8	4.0
Subj. 12	1	1	1	1	2	3.4	3.0	2.9	3.8
Subj. 13	1	1	2	2	1	3.5	2.5	4.4	2.4
Subj. 14	1	1	2	2	1	3.7	2.5	2.9	3.7
Subj. 15	1	1	1	1	3	3.6	2.8	4.0	4.2
Subj. 16	1	2	1	1	3	3.9	2.8	2.9	3.2
Subj. 17	1	1	1	2	3	2.9	2.7	3.3	2.9
Subj. 18	1	1	1	2	2	3.8	3.3	3.7	3.9
Subj. 19	1	1	1	2	3	3.0	2.8	3.1	2.6
Subj. 20	1	2	1	2	3	3.0	2.3	2.8	2.4
Subj. 21	1	1	1	1	3	3.6	2.6	2.6	3.5
Subj. 22	1	2	1	1	1	2.6	3.4	3.0	2.9
Subj. 23	1	1	1	2	2	3.5	2.8	2.6	3.1
Subj. 24	1	2	1	2	2	3.3	3.0	3.3	3.0
Subj. 25	1	1	1	2	2	3.8	2.6	2.8	3.7
Subj. 26	1	2	1	2	2	3.4	2.7	2.6	3.5
Subj. 27	1	1	1	2	3	3.2	2.7	3.1	3.0
Subj. 28	1	1	1	2	2	2.7	2.5	3.6	2.6
Subj. 29	1	1	1	1	2	3.4	2.7	2.8	3.3
Subj. 30	1	1	2	1	3	3.3	2.6	3.0	3.0
Subj. 31	1	1	1	2	1	3.5	2.7	2.7	3.2

Table 31. LN Transformation of Response Time for Statistical Analyses (continued).

Subject	Data	Gender	Rank	Educ.	Mode> / Task> / Train.	3D-Line HH	3D-Line HL	3D-Line LH	3D-Line LL
Subj. 32	2	1	1	1	3	3.5	2.9	3.5	3.1
Subj. 33	2	2	2	2	2	2.8	2.6	2.8	3.7
Subj. 34	2	2	1	1	1	3.1	2.3	3.2	3.5
Subj. 35	2	2	1	1	3	2.9	3.0	2.9	4.1
Subj. 36	2	1	1	1	3	3.7	2.5	3.1	2.8
Subj. 37	2	1	1	1	3	3.5	2.3	3.4	3.5
Subj. 38	2	2	1	1	1	3.1	3.1	3.2	3.5
Subj. 39	2	1	1	2	1	2.8	2.5	2.4	2.8
Subj. 40	2	1	1	2	1	2.8	2.3	3.0	2.9
Subj. 41	2	1	2	2	1	3.3	2.5	2.7	2.8
Subj. 42	2	1	1	2	3	3.1	3.5	2.8	4.3
Subj. 43	2	2	1	1	1	3.1	2.7	3.2	3.0
Subj. 44	2	2	1	1	3	3.9	2.9	3.3	4.2
Subj. 45	2	1	2	2	1	3.7	3.5	2.6	4.2
Subj. 46	2	1	2	2	3	3.0	2.3	2.3	2.9
Subj. 47	2	2	1	1	2	3.1	3.0	3.3	3.1
Subj. 48	2	2	2	2	3	3.0	2.7	3.3	2.7
Subj. 49	2	1	1	2	2	3.4	2.3	3.1	3.1
Subj. 50	2	1	1	2	3	2.6	2.7	3.0	4.9
Subj. 51	2	1	1	2	3	4.3	2.8	2.7	3.8
Subj. 52	2	1	1	2	2	3.4	2.6	3.1	3.9
Subj. 53	2	1	1	1	1	3.6	2.8	2.6	3.3
Subj. 54	2	1	2	2	2	3.3	2.4	3.1	3.9
Subj. 55	2	1	1	2	3	2.8	3.1	2.6	3.6
Subj. 56	2	1	1	2	1	2.9	2.4	2.8	3.6
Subj. 57	2	1	2	1	1	3.2	2.5	2.4	3.1
Subj. 58	2	1	1	1	1	3.9	3.6	2.6	3.0
Subj. 59	2	1	1	1	3	3.5	2.6	2.6	3.4
Subj. 60	2	1	1	1	3	3.3	2.9	2.8	4.0
Subj. 61	2	1	1	1	3	3.4	3.1	3.1	3.6
Subj. 62	2	1	1	1	3	2.8	2.8	2.6	3.0

Appendix F. Variance-Covariance Matrix Calculations and Power Test

This appendix contains the variance-covariance matrices and the calculations performed to test whether or not they met the homogeneity and circularity criteria (Tables 32-38). The appendix also includes the calculations performed to determine the power of the F tests used in this experiment (Table 39).

Table 32. Matrix Calculations for Homogeneity and Circularity Tests.

N'=	60
n'=	30
p=	2
q=	20
|S1|=	1.08E-21
|S2|=	4.32E-22
|Spooled|=	6.49E-19
|So|=	8.73E-17
n'*ln|S1|=	-1448.36
n'*ln|S2|=	-1475.82
Total=	-2924.18
N'*ln|Spooled|=	-2512.77

Table 33. Test for Homogeneity.

M1=	411.419
C1=	0.341
f1=	210.000
X1^2=	271.177
X1^2(.05,210)=	244.808
Pvalue=	0.003

Table 34. Test for Circularity.

M2=	284.351
C2=	0.119
f2=	208.000
X2^2=	250.614
X2^2(.05,208)=	242.647
Pvalue=	0.023

Table 35. Variance-Covariance Matrix for Group 1 (G1).

S1	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
A	0.207	0.052	0.067	0.064	0.047	0.090	0.013	0.021	0.017	0.036	0.122	0.093	0.053	0.061	0.053	0.077	0.016	0.019	0.084	0.028
B	0.052	0.088	0.042	0.052	0.058	0.034	0.010	0.025	0.023	0.010	0.052	0.084	0.039	0.029	0.016	0.027	0.008	0.032	0.018	0.071
C	0.067	0.042	0.208	0.124	0.030	0.107	0.042	0.068	0.021	0.059	0.089	0.064	0.044	0.042	0.058	0.103	0.046	0.052	0.057	0.067
D	0.064	0.052	0.124	0.232	0.039	0.106	0.058	0.094	0.046	0.087	0.095	0.075	0.035	0.037	0.038	0.140	0.058	0.068	0.072	0.124
E	0.047	0.058	0.030	0.039	0.174	0.022	0.011	0.075	-0.007	-0.026	0.022	0.064	0.046	0.032	0.031	-0.006	-0.026	0.017	0.013	0.054
F	0.090	0.034	0.107	0.106	0.022	0.142	0.054	0.076	0.022	0.066	0.098	0.090	0.040	0.031	0.061	0.103	0.008	0.033	0.041	0.074
G	0.013	0.010	0.042	0.058	0.011	0.054	0.147	0.052	0.018	0.010	0.059	0.006	0.070	0.026	0.035	0.068	0.032	0.016	0.026	0.051
H	0.021	0.025	0.068	0.094	0.075	0.076	0.052	0.270	-0.003	0.002	0.074	0.052	0.045	0.010	0.027	0.105	0.058	0.009	0.073	0.109
I	0.017	0.023	0.021	0.046	-0.007	0.022	0.018	-0.003	0.126	0.033	0.061	0.014	0.048	-0.019	0.020	0.076	0.053	0.021	-0.015	0.013
J	0.036	0.010	0.059	0.087	-0.026	0.066	0.010	0.002	0.033	0.208	0.065	0.018	0.003	-0.001	0.044	0.102	0.021	0.030	0.045	0.023
K	0.122	0.052	0.089	0.095	0.022	0.098	0.059	0.074	0.061	0.065	0.184	0.108	0.070	0.042	0.053	0.141	0.080	0.046	0.019	0.099
L	0.093	0.084	0.064	0.075	0.064	0.090	0.006	0.052	0.014	0.018	0.108	0.270	0.041	0.059	0.042	0.045	0.019	0.052	-0.045	0.103
M	0.053	0.039	0.044	0.035	0.046	0.040	0.070	0.045	0.048	0.003	0.070	0.041	0.115	0.039	0.017	0.038	0.046	0.025	0.058	0.045
N	0.061	0.029	0.042	0.037	0.032	0.031	0.026	0.010	-0.019	-0.001	0.042	0.059	0.039	0.100	0.004	0.038	0.006	0.036	0.032	0.069
O	0.053	0.016	0.058	0.038	0.031	0.061	0.035	0.027	0.020	0.044	0.053	0.042	0.017	0.004	0.113	0.044	-0.008	0.008	-0.011	0.011
P	0.077	0.027	0.103	0.140	-0.006	0.103	0.068	0.105	0.076	0.102	0.141	0.045	0.038	0.038	0.044	0.243	0.062	0.044	0.013	0.124
Q	0.016	0.008	0.046	0.058	-0.026	0.008	0.032	0.058	0.053	0.021	0.080	0.019	0.046	0.006	-0.008	0.062	0.151	0.000	0.022	0.065
R	0.019	0.032	0.052	0.068	0.017	0.033	0.016	0.009	0.021	0.030	0.046	0.052	0.025	0.036	0.008	0.044	0.000	0.093	0.005	0.055
S	0.084	0.018	0.057	0.072	0.013	0.041	0.026	0.073	-0.015	0.045	0.019	-0.045	0.058	0.032	-0.011	0.013	0.022	0.005	0.248	-0.033
T	0.028	0.071	0.067	0.124	0.054	0.074	0.051	0.109	0.013	0.023	0.099	0.103	0.045	0.069	0.011	0.124	0.065	0.055	-0.033	0.273

Table 36. Variance-Covariance Matrix for Group 2 (G2).

S2	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
A	0.161	0.032	-0.003	0.060	0.046	0.095	0.038	0.026	0.042	0.042	0.044	0.086	-0.003	0.047	0.004	0.045	0.039	0.040	-0.030	0.043
B	0.032	0.220	0.017	0.021	0.017	0.084	0.022	0.035	0.007	0.093	0.017	0.037	0.042	0.089	0.056	0.016	0.092	0.087	0.117	0.050
C	-0.003	0.017	0.202	-0.038	0.034	-0.014	-0.055	0.125	0.036	0.045	0.032	0.038	0.041	0.076	-0.048	0.038	0.012	0.030	0.051	0.024
D	0.060	0.021	-0.038	0.207	0.054	0.076	0.077	-0.031	0.050	0.037	-0.001	0.065	0.000	0.022	0.020	0.053	0.100	0.090	0.016	0.026
E	0.046	0.017	0.034	0.054	0.117	0.030	0.034	-0.006	0.045	0.026	0.012	0.036	0.004	0.062	-0.010	-0.002	0.042	0.036	0.049	0.028
F	0.095	0.084	-0.014	0.076	0.030	0.126	0.050	0.010	0.036	0.052	0.041	0.074	-0.006	0.037	0.044	0.037	0.060	0.086	0.029	0.013
G	0.038	0.022	-0.055	0.077	0.034	0.050	0.195	-0.030	0.110	0.001	0.015	0.028	-0.017	0.071	0.041	0.004	0.045	0.056	0.050	0.045
H	0.026	0.035	0.125	-0.031	-0.006	0.010	-0.030	0.186	0.031	0.030	0.004	0.034	0.038	0.080	-0.044	0.060	-0.002	0.004	0.019	0.047
I	0.042	0.007	0.036	0.050	0.045	0.036	0.110	0.031	0.396	-0.005	0.045	0.070	-0.004	0.025	0.055	0.046	0.016	0.072	0.012	0.089
J	0.042	0.093	0.045	0.037	0.026	0.052	0.001	0.030	-0.005	0.169	0.020	0.041	0.045	0.110	-0.044	0.019	0.039	0.063	0.070	0.010
K	0.044	0.017	0.032	-0.001	0.012	0.041	0.015	0.004	0.045	0.020	0.143	0.036	0.012	0.004	0.051	0.000	-0.025	0.066	0.014	0.021
L	0.086	0.037	0.038	0.065	0.036	0.074	0.028	0.034	0.070	0.041	0.036	0.138	-0.010	0.068	-0.001	0.037	0.047	0.055	0.015	-0.007
M	-0.003	0.042	0.041	0.000	0.004	-0.006	-0.017	0.038	-0.004	0.045	0.012	-0.010	0.102	0.018	0.000	0.013	0.003	0.045	0.025	0.016
N	0.047	0.089	0.076	0.022	0.062	0.037	0.071	0.080	0.025	0.110	0.004	0.068	0.018	0.293	-0.043	0.021	0.067	0.073	0.121	0.079
O	0.004	0.056	-0.048	0.020	-0.010	0.044	0.041	-0.044	0.055	-0.044	0.051	-0.001	0.000	-0.043	0.150	0.001	0.086	0.023	0.033	0.047
P	0.045	0.016	0.038	0.053	-0.002	0.037	0.004	0.060	0.046	0.019	0.000	0.037	0.013	0.021	0.001	0.070	0.047	0.031	-0.008	0.032
Q	0.039	0.092	0.012	0.100	0.042	0.060	0.045	-0.002	0.016	0.039	-0.025	0.047	0.003	0.067	0.086	0.047	0.270	-0.003	0.035	0.050
R	0.040	0.087	0.030	0.090	0.036	0.086	0.056	0.004	0.072	0.063	0.066	0.055	0.045	0.073	0.023	0.031	-0.003	0.240	0.075	0.007
S	-0.030	0.117	0.051	0.016	0.049	0.029	0.050	0.019	0.012	0.070	0.014	0.015	0.025	0.121	0.033	-0.008	0.035	0.075	0.194	0.048
T	0.043	0.050	0.024	0.026	0.028	0.013	0.045	0.047	0.089	0.010	0.021	-0.007	0.016	0.079	0.047	0.032	0.050	0.007	0.048	0.141

Table 37. Pooled Variance-Covariance Matrix.

Sp	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
A	0.184	0.042	0.032	0.062	0.047	0.092	0.026	0.023	0.030	0.039	0.083	0.089	0.025	0.054	0.029	0.061	0.027	0.029	0.027	0.036
B	0.042	0.154	0.030	0.036	0.038	0.059	0.016	0.030	0.015	0.051	0.035	0.060	0.040	0.059	0.036	0.021	0.050	0.059	0.067	0.060
C	0.032	0.030	0.205	0.043	0.032	0.046	-0.007	0.096	0.028	0.052	0.061	0.051	0.042	0.059	0.005	0.071	0.029	0.041	0.054	0.045
D	0.062	0.036	0.043	0.219	0.046	0.091	0.067	0.031	0.048	0.062	0.047	0.070	0.018	0.029	0.029	0.096	0.079	0.079	0.044	0.075
E	0.047	0.038	0.032	0.046	0.145	0.026	0.023	0.035	0.019	0.000	0.017	0.050	0.025	0.047	0.010	-0.004	0.008	0.026	0.031	0.041
F	0.092	0.059	0.046	0.091	0.026	0.134	0.052	0.043	0.029	0.059	0.070	0.082	0.017	0.034	0.052	0.070	0.034	0.059	0.035	0.044
G	0.026	0.016	-0.007	0.067	0.023	0.052	0.171	0.011	0.064	0.005	0.037	0.017	0.026	0.048	0.038	0.036	0.038	0.036	0.038	0.048
H	0.023	0.030	0.096	0.031	0.035	0.043	0.011	0.228	0.014	0.016	0.039	0.043	0.041	0.045	-0.009	0.082	0.028	0.007	0.046	0.078
I	0.030	0.015	0.028	0.048	0.019	0.029	0.064	0.014	0.261	0.014	0.053	0.042	0.022	0.003	0.037	0.061	0.034	0.047	-0.001	0.051
J	0.039	0.051	0.052	0.062	0.000	0.059	0.005	0.016	0.014	0.188	0.042	0.030	0.024	0.055	0.000	0.060	0.030	0.047	0.057	0.016
K	0.083	0.035	0.061	0.047	0.017	0.070	0.037	0.039	0.053	0.042	0.164	0.072	0.041	0.023	0.052	0.070	0.028	0.056	0.017	0.060
L	0.089	0.060	0.051	0.070	0.050	0.082	0.017	0.043	0.042	0.030	0.072	0.204	0.015	0.064	0.021	0.041	0.033	0.054	-0.015	0.048
M	0.025	0.040	0.042	0.018	0.025	0.017	0.026	0.041	0.022	0.024	0.041	0.015	0.108	0.028	0.009	0.025	0.025	0.035	0.041	0.030
N	0.054	0.059	0.059	0.029	0.047	0.034	0.048	0.045	0.003	0.055	0.023	0.064	0.028	0.196	-0.019	0.029	0.036	0.054	0.076	0.074
O	0.029	0.036	0.005	0.029	0.010	0.052	0.038	-0.009	0.037	0.000	0.052	0.021	0.009	-0.019	0.131	0.022	0.039	0.016	0.011	0.029
P	0.061	0.021	0.071	0.096	-0.004	0.070	0.036	0.082	0.061	0.060	0.070	0.041	0.025	0.029	0.022	0.157	0.054	0.037	0.003	0.078
Q	0.027	0.050	0.029	0.079	0.008	0.034	0.038	0.028	0.034	0.030	0.028	0.033	0.025	0.036	0.039	0.054	0.211	-0.001	0.028	0.057
R	0.029	0.059	0.041	0.079	0.026	0.059	0.036	0.007	0.047	0.047	0.056	0.054	0.035	0.054	0.016	0.037	-0.001	0.166	0.040	0.031
S	0.027	0.067	0.054	0.044	0.031	0.035	0.038	0.046	-0.001	0.057	0.017	-0.015	0.041	0.076	0.011	0.003	0.028	0.040	0.221	0.008
T	0.036	0.060	0.045	0.075	0.041	0.044	0.048	0.078	0.051	0.016	0.060	0.048	0.030	0.074	0.029	0.078	0.057	0.031	0.008	0.207

Table 38. So Variance-Covariance Matrix.

So	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
A	0.183	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
B	0.039	0.183	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
C	0.039	0.039	0.183	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
D	0.039	0.039	0.039	0.183	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
E	0.039	0.039	0.039	0.039	0.183	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
F	0.039	0.039	0.039	0.039	0.039	0.183	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
G	0.039	0.039	0.039	0.039	0.039	0.039	0.183	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
H	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.183	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
I	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.183	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
J	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.183	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
K	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.183	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
L	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.183	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
M	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.183	0.039	0.039	0.039	0.039	0.039	0.039	0.039
N	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.183	0.039	0.039	0.039	0.039	0.039	0.039
O	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.183	0.039	0.039	0.039	0.039	0.039
P	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.183	0.039	0.039	0.039	0.039
Q	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.183	0.039	0.039	0.039
R	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.183	0.039	0.039
S	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.183	0.039
T	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.183

Table 39. Power Test Calculations

Means (u)

	c1	c2	c3	c4
b1	2.8088	2.8553	2.9884	3.8311
b2	2.8222	2.8725	2.8445	3.6203
b3	2.9022	3.0653	2.8561	3.6900
b4	2.7868	2.9222	2.8747	3.4621
b5	3.2467	2.7607	2.9868	3.3757

Mean of Means (u.)

3.0786

(u-u.)^2

	c1	c2	c3	c4
b1	0.0728	0.0499	0.0081	0.5663
b2	0.0658	0.0425	0.0548	0.2934
b3	0.0311	0.0002	0.0495	0.3738
b4	0.0852	0.0245	0.0416	0.1471
b5	0.0282	0.1011	0.0084	0.0883

Knowns (Conservative F test)

$\nu 1$ 1.0 $\nu 2$ 60.0

r 20.0

Calculated

σ 0.5382 ϕ 3.4

Power> 0.99

Appendix G. Analysis of Variance

This appendix contains the summary tables and summary analysis of variance tables used in the statistical analysis provided in Chapter 4. There are five cases in all. In each case Factor A represents a different factor. In Tables 40 and 41 Factor A is the data-set combinations. Factor A is training level in Tables 42 and 43, and rank in Tables 44 and 45. In Tables 46 and 47 Factor A is Gender, and Factor A is educational level in Tables 48 and 49.

Table 40. Summary of Analysis of Variance
for Data-Set Combination (Factor A)

Known Values		Source of Variation	SS	df	MS	F
N= 31		Between Subjects	56.23325	61		
P= 2		A	0.328623	1	0.328623	0.352696
Q= 5		Subj w. groups (error (a))	55.90463	60	0.931744	
R= 4						
		Within subjects	302.9229	1178		
		B	2.597779	4	0.649445	5.032551
Equation Values		AB	3.449816	4	0.862454	6.68316
1	11752.61	B X subj w. groups (error (b))	30.97171	240	0.129049	
2	12111.76					
3	11752.94					
4	11755.21	C	110.6427	3	36.88089	221.9426
5	11863.25	AC	0.437416	3	0.145805	0.87743
6	11758.98	C X subj w. groups (error (c))	29.91115	180	0.166173	
7	11864.02					
8	11884.83					
9	11892.43	BC	18.97809	12	1.581508	11.10458
10	11808.84	ABC	3.392348	12	0.282696	1.984952
11	11845.86	BC X subj w. groups (error (bc))	102.5419	720	0.142419	
12	11949.83					

Table 41. ANOVA Summary Tables for Data-Set Combination (Factor A).

ABC SUMMARY TABLE

	B1				B2				B3				B4				B5			
	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4
A1	87.3	89.6	94.3	120.7	89.3	86.9	86.5	108.2	91.0	97.2	87.7	116.0	84.6	88.7	81.8	105.7	100.5	85.8	94.8	102.0
A2	86.8	87.5	91.0	116.8	85.6	91.1	89.9	116.2	89.0	92.9	89.4	112.7	88.2	92.5	96.4	109.0	100.8	85.4	90.3	107.3
TOTAL	174.1	177.0	185.3	237.5	175.0	178.1	176.4	224.5	179.9	190.0	177.1	228.8	172.8	181.2	178.2	214.7	201.3	171.2	185.2	209.3

AB SUMMARY TABLE

	B1	B2	B3	B4	B5	TOTAL
A1	391.9	371.0	391.8	360.8	383.2	1898.7
A2	382.1	382.9	384.0	386.1	383.7	1918.8
TOTAL	774.0	753.9	775.8	746.8	766.9	3817.5

AC SUMMARY TABLE

	C1	C2	C3	C4	TOTAL
A1	452.7	448.2	445.1	552.7	1898.7
A2	450.4	449.3	457.0	562.1	1918.8
TOTAL	903.1	897.5	902.1	1114.7	3817.5

BC SUMMARY TABLE

	C1	C2	C3	C4	TOTAL
B1	174.1	177.0	185.3	237.5	774.0
B2	175.0	178.1	176.4	224.5	753.9
B3	179.9	190.0	177.1	228.8	775.8
B4	172.8	181.2	178.2	214.7	746.8
B5	201.3	171.2	185.2	209.3	766.9
TOTAL	903.1	897.5	902.1	1114.7	3817.5

Table 41. ANOVA Summary Tables
for Data-Set Combination (Factor A) (continued).

B X subj w. G1 SUMMARY TABLE

SUBJ #	B1	B2	B3	B4	B5
1	13.41	11.52	11.16	11.34	13.44
2	14.28	11.89	13.39	12.64	12.96
3	10.72	9.87	12.25	10.48	11.53
4	10.44	11.58	10.32	10.42	10.53
5	11.79	11.92	12.76	10.58	12.71
6	11.31	11.70	12.90	11.97	12.08
7	14.10	13.74	14.35	13.68	12.17
8	13.35	13.05	12.63	11.38	14.08
9	14.29	14.56	13.64	11.77	12.88
10	10.96	11.64	9.80	10.96	10.48
11	13.27	12.72	12.23	11.50	12.19
12	11.42	11.08	12.13	11.45	13.12
13	13.67	12.63	12.16	12.38	12.82
14	12.62	12.88	13.91	11.99	12.81
15	13.87	14.42	12.80	13.50	14.56
16	13.42	11.35	13.42	11.93	12.79
17	10.66	10.75	10.61	10.22	11.86
18	15.06	12.91	14.95	13.77	14.53
19	12.92	12.07	13.41	10.75	11.59
20	10.75	10.87	12.41	11.00	10.47
21	12.66	12.79	12.48	11.80	12.31
22	13.82	10.48	14.07	11.65	12.03
23	13.43	11.34	12.89	11.45	11.95
24	12.13	12.27	12.45	11.34	12.51
25	13.00	12.22	13.32	11.91	12.89
26	12.04	10.73	12.72	11.55	12.25
27	11.38	10.94	12.49	11.31	12.06
28	12.21	11.21	10.88	10.43	11.34
29	13.17	13.61	14.18	13.34	12.24
30	13.19	11.24	12.50	11.80	11.86
31	12.51	11.02	12.64	10.51	12.16

C X subj w. G1 SUMMARY TABLE

SUBJ #	C1	C2	C3	C4
1	15.46	14.23	13.98	17.20
2	14.96	15.97	14.44	19.80
3	12.90	13.95	12.21	15.79
4	13.13	12.94	11.87	15.35
5	14.39	14.51	14.88	15.97
6	15.81	13.74	12.95	17.45
7	15.09	17.25	16.34	19.35
8	14.28	15.19	14.68	20.34
9	16.58	14.70	14.87	21.00
10	12.64	12.87	13.60	14.73
11	12.88	14.40	14.42	20.21
12	14.02	14.17	13.43	17.58
13	16.33	13.91	16.33	17.07
14	15.47	14.52	15.48	18.74
15	15.53	16.10	17.24	20.28
16	15.12	14.85	15.08	17.84
17	12.10	12.50	13.08	16.41
18	15.94	17.03	16.73	21.53
19	14.63	14.77	14.04	17.30
20	12.92	13.29	12.77	16.51
21	14.88	14.11	14.23	18.81
22	14.56	16.11	14.33	17.06
23	14.30	14.13	15.29	17.35
24	14.35	14.79	13.96	17.59
25	15.77	14.51	14.12	18.93
26	14.71	13.89	13.29	17.40
27	14.98	13.40	13.15	16.64
28	13.76	13.70	13.53	15.09
29	16.21	14.57	16.02	19.75
30	15.23	13.93	15.55	15.89
31	13.78	14.14	13.22	17.70

Table 41. ANOVA Summary Tables
for Data-Set Combination (Factor A) (continued).

B X subj w. G2 SUMMARY TABLE

SUBJ #	B1	B2	B3	B4	B5
32	11.65	10.59	11.56	12.08	12.97
33	12.12	12.98	11.90	12.18	11.86
34	12.34	11.13	11.91	13.56	12.08
35	12.71	13.10	14.86	13.88	12.94
36	12.25	12.33	11.53	13.78	12.06
37	13.49	13.02	13.14	11.70	12.70
38	10.87	12.46	12.08	12.76	12.96
39	10.29	11.01	11.13	10.59	10.49
40	12.40	10.84	11.64	10.46	11.02
41	11.43	10.29	11.06	11.34	11.22
42	13.19	12.17	12.76	12.76	13.64
43	12.13	11.71	12.78	12.34	12.07
44	12.95	12.94	13.35	13.22	14.20
45	11.74	13.68	13.29	13.18	14.10
46	10.55	10.05	11.07	10.79	10.49
47	11.92	12.50	12.97	11.77	12.57
48	12.90	12.76	12.65	11.26	11.72
49	13.32	13.91	11.63	12.31	11.96
50	12.64	13.19	12.23	13.98	13.30
51	12.20	13.14	12.10	13.07	13.60
52	12.55	14.08	13.49	12.90	12.92
53	13.78	12.38	12.47	11.45	12.26
54	12.10	13.90	11.55	13.10	12.63
55	13.82	13.38	12.04	12.87	12.14
56	11.20	11.60	10.82	10.34	11.76
57	11.15	11.12	11.92	12.50	11.19
58	14.98	12.71	14.19	13.15	13.12
59	10.99	11.47	12.50	11.60	12.16
60	13.56	13.54	13.86	12.92	13.08
61	12.16	12.36	12.41	13.78	13.23
62	12.76	12.55	13.12	14.45	11.30

C X subj w. G2 SUMMARY TABLE

SUBJ #	C1	C2	C3	C4
32	14.27	12.96	14.56	17.06
33	14.00	15.83	14.32	16.90
34	14.58	14.91	16.04	15.50
35	14.55	16.41	17.40	19.14
36	15.89	14.16	14.44	17.45
37	15.34	13.63	15.86	19.22
38	13.65	13.80	15.30	18.38
39	12.55	11.82	12.95	16.17
40	13.42	13.16	12.45	17.34
41	13.31	13.53	12.82	15.69
42	13.42	16.31	15.34	19.43
43	13.96	15.27	14.53	17.26
44	14.93	15.13	15.53	21.07
45	15.70	15.31	15.08	19.90
46	12.79	12.41	11.83	15.93
47	14.12	15.54	14.19	17.88
48	13.68	14.84	15.45	17.32
49	14.74	13.61	15.60	19.18
50	15.22	14.13	14.56	21.43
51	16.41	14.69	14.74	18.27
52	17.03	14.74	14.46	19.70
53	15.57	14.08	14.46	18.23
54	14.30	15.22	14.07	19.70
55	15.70	14.69	15.95	17.91
56	12.73	13.15	13.28	16.55
57	14.20	13.33	14.90	15.45
58	15.87	16.24	16.54	19.49
59	14.39	13.90	13.66	16.78
60	15.55	15.54	15.74	20.13
61	14.99	15.32	14.98	18.64
62	13.53	15.69	16.00	18.97

Table 42. Summary of Analysis of Variance
for Training Level (Factor A).

Known Values		Source of Variation	SS	df	MS	F
N1= 21		Between Subjects	56.23325	61		
N2= 17		A	1.393784	2	0.696892	0.749763
N3= 24		Subj w. groups	54.83947	59	0.929483	
N= 62		(error (a))				
P= 2						
Q= 5		Within subjects	302.9229	1178		
R= 4		B	2.597779	4	0.649445	4.547062
Equation Values		AB	0.714277	8	0.089285	0.625123
1	11752.61	B X subj w. groups	33.70725	236	0.142827	
2	12111.76	(error (b))				
3	11754.00					
4	11755.21	C	110.6427	3	36.88089	225.2115
5	11863.25	AC	1.362849	6	0.227141	1.387029
6	11757.31	C X subj w. groups	28.98572	177	0.163761	
7	11866.01	(error (c))				
8	11884.83					
9	11891.65	BC	18.97809	12	1.581508	10.91541
10	11808.84	ABC	3.353829	24	0.139743	0.964491
11	11845.86	BC X subj w. groups	102.5805	708	0.144888	
12	11949.83	(error (bc))				

Table 43. ANOVA Summary Tables for Training Level (Factor A).

ABC SUMMARY TABLE

	B1				B2				B3				B4				B5			
	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4
A1	60.6	60.5	60.6	79.2	59.2	58.1	58.9	73.0	60.0	62.9	59.3	77.5	58.1	59.7	60.7	68.9	67.7	58.0	62.9	68.0
A2	47.8	49.0	50.0	66.3	50.6	50.2	47.7	62.1	50.3	53.5	48.4	62.1	44.2	51.5	47.6	60.3	54.4	46.1	50.2	58.5
A3	65.8	67.5	74.7	92.0	65.2	69.8	69.7	89.3	69.7	73.6	69.4	89.2	70.4	70.0	69.9	85.5	79.2	67.1	72.1	82.8
TOTAL	174.1	177.0	185.3	237.5	175.0	178.1	176.4	224.5	179.9	190.0	177.1	228.8	172.8	181.2	178.2	214.7	201.3	171.2	185.2	209.3

AB SUMMARY TABLE

	B1	B2	B3	B4	B5	TOTAL
A1	261.0	249.2	259.7	247.4	256.6	1273.9
A2	213.0	210.7	214.2	203.6	209.2	1050.6
A3	300.0	294.1	301.9	295.8	301.1	1492.9
TOTAL	774.0	753.9	775.8	746.8	766.9	3817.5

AC SUMMARY TABLE

	C1	C2	C3	C4	TOTAL
A1	305.5	299.3	302.4	366.7	1273.9
A2	247.3	250.3	243.8	309.3	1050.6
A3	350.4	347.9	355.9	438.8	1492.9
TOTAL	903.1	897.5	902.1	1114.7	3817.5

BC SUMMARY TABLE

	C1	C2	C3	C4	TOTAL
B1	174.1	177.0	185.3	237.5	774.0
B2	175.0	178.1	176.4	224.5	753.9
B3	179.9	190.0	177.1	228.8	775.8
B4	172.8	181.2	178.2	214.7	746.8
B5	201.3	171.2	185.2	209.3	766.9
TOTAL	903.1	897.5	902.1	1114.7	3817.5

Table 43. ANOVA Summary Tables
for Training Level (Factor A) (continued).

B X subj w. G1 SUMMARY TABLE

SUBJ #	B1	B2	B3	B4	B5
1	13.41	11.52	11.16	11.34	13.44
2	14.28	11.89	13.39	12.64	12.96
5	11.79	11.92	12.76	10.58	12.71
6	11.31	11.70	12.90	11.97	12.08
9	14.29	14.56	13.64	11.77	12.88
10	10.96	11.64	9.80	10.96	10.48
13	13.67	12.63	12.16	12.38	12.82
14	12.62	12.88	13.91	11.99	12.81
22	13.82	10.48	14.07	11.65	12.03
31	12.51	11.02	12.64	10.51	12.16
34	12.34	11.13	11.91	13.56	12.08
38	10.87	12.46	12.08	12.76	12.96
39	10.29	11.01	11.13	10.59	10.49
40	12.40	10.84	11.64	10.46	11.02
41	11.43	10.29	11.06	11.34	11.22
43	12.13	11.71	12.78	12.34	12.07
45	11.74	13.68	13.29	13.18	14.10
53	13.78	12.38	12.47	11.45	12.26
56	11.20	11.60	10.82	10.34	11.76
57	11.15	11.12	11.92	12.50	11.19
58	14.98	12.71	14.19	13.15	13.12

C X subj w. G1 SUMMARY TABLE

SUBJ #	C1	C2	C3	C4
1	15.46	14.23	13.98	17.20
2	14.96	15.97	14.44	19.80
5	14.39	14.51	14.88	15.97
6	15.81	13.74	12.95	17.45
9	16.58	14.70	14.87	21.00
10	12.64	12.87	13.60	14.73
13	16.33	13.91	16.33	17.07
14	15.47	14.52	15.48	18.74
22	14.56	16.11	14.33	17.06
31	13.78	14.14	13.22	17.70
34	14.58	14.91	16.04	15.50
38	13.65	13.80	15.30	18.38
39	12.55	11.82	12.95	16.17
40	13.42	13.16	12.45	17.34
41	13.31	13.53	12.82	15.69
43	13.96	15.27	14.53	17.26
45	15.70	15.31	15.08	19.90
53	15.57	14.08	14.46	18.23
56	12.73	13.15	13.28	16.55
57	14.20	13.33	14.90	15.45
58	15.87	16.24	16.54	19.49

B X subj w. G2 SUMMARY TABLE

SUBJ #	B1	B2	B3	B4	B5
11	13.27	12.72	12.23	11.50	12.19
12	11.42	11.08	12.13	11.45	13.12
18	15.06	12.91	14.95	13.77	14.53
23	13.43	11.34	12.89	11.45	11.95
24	12.13	12.27	12.45	11.34	12.51
25	13.00	12.22	13.32	11.91	12.89
26	12.04	10.73	12.72	11.55	12.25
28	12.21	11.21	10.88	10.43	11.34
29	13.17	13.61	14.18	13.34	12.24
33	12.12	12.98	11.90	12.18	11.86
47	11.92	12.50	12.97	11.77	12.57
49	13.32	13.91	11.63	12.31	11.96
52	12.55	14.08	13.49	12.90	12.92
54	12.10	13.90	11.55	13.10	12.63

C X subj w. G2 SUMMARY TABLE

SUBJ #	C1	C2	C3	C4
11	12.88	14.40	14.42	20.21
12	14.02	14.17	13.43	17.58
18	15.94	17.03	16.73	21.53
23	14.30	14.13	15.29	17.35
24	14.35	14.79	13.96	17.59
25	15.77	14.51	14.12	18.93
26	14.71	13.89	13.29	17.40
28	13.76	13.70	13.53	15.09
29	16.21	14.57	16.02	19.75
33	14.00	15.83	14.32	16.90
47	14.12	15.54	14.19	17.88
49	14.74	13.61	15.60	19.18
52	17.03	14.74	14.46	19.70
54	14.30	15.22	14.07	19.70

Table 43. ANOVA Summary Tables
for Training Level (Factor A) (continued).

B X subj w. G3 SUMMARY TABLE

SUBJ #	B1	B2	B3	B4	B5
17	10.66	10.75	10.61	10.22	11.86
19	12.92	12.07	13.41	10.75	11.59
20	10.75	10.87	12.41	11.00	10.47
21	12.66	12.79	12.48	11.80	12.31
27	11.38	10.94	12.49	11.31	12.06
30	13.19	11.24	12.50	11.80	11.86
32	11.65	10.59	11.56	12.08	12.97
35	12.71	13.10	14.86	13.88	12.94
36	12.25	12.33	11.53	13.78	12.06
37	13.49	13.02	13.14	11.70	12.70
42	13.19	12.17	12.76	12.76	13.64
44	12.95	12.94	13.35	13.22	14.20
46	10.55	10.05	11.07	10.79	10.49
48	12.90	12.76	12.65	11.26	11.72
50	12.64	13.19	12.23	13.98	13.30
51	12.20	13.14	12.10	13.07	13.60
55	13.82	13.38	12.04	12.87	12.14
59	10.99	11.47	12.50	11.60	12.16
60	13.56	13.54	13.86	12.92	13.08
61	12.16	12.36	12.41	13.78	13.23
62	12.76	12.55	13.12	14.45	11.30

C X subj w. G3 SUMMARY TABLE

SUBJ #	C1	C2	C3	C4
17	12.10	12.50	13.08	16.41
19	14.63	14.77	14.04	17.30
20	12.92	13.29	12.77	16.51
21	14.88	14.11	14.23	18.81
27	14.98	13.40	13.15	16.64
30	15.23	13.93	15.55	15.89
32	14.27	12.96	14.56	17.06
35	14.55	16.41	17.40	19.14
36	15.89	14.16	14.44	17.45
37	15.34	13.63	15.86	19.22
42	13.42	16.31	15.34	19.43
44	14.93	15.13	15.53	21.07
46	12.79	12.41	11.83	15.93
48	13.68	14.84	15.45	17.32
50	15.22	14.13	14.56	21.43
51	16.41	14.69	14.74	18.27
55	15.70	14.69	15.95	17.91
59	14.39	13.90	13.66	16.78
60	15.55	15.54	15.74	20.13
61	14.99	15.32	14.98	18.64
62	13.53	15.69	16.00	18.97

Table 44. Summary of Analysis of Variance
for Rank (Factor A).

Known Values		Source of Variation	SS	df	MS	F
N1= 48		Between Subjects	56.23325	61		
N2= 14		A	0.091199	1	0.091199	0.097466
N= 62		Subj w. groups	56.14205	60	0.935701	
P= 2		(error (a))				
Q= 5						
R= 4		Within subjects	302.9229	1178		
		B	2.597779	4	0.649445	4.547203
Equation Values		AB	0.144031	4	0.036008	0.252114
1	11752.61	B X subj w. groups	34.2775	240	0.142823	
2	12111.76	(error (b))				
3	11752.70					
4	11755.21	C	110.6427	3	36.88089	219.9667
5	11863.25	AC	0.16873	3	0.056243	0.335449
6	11755.44	C X subj w. groups	30.17984	180	0.167666	
7	11863.51	(error (c))				
8	11884.83					
9	11886.36	BC	18.97809	12	1.581508	10.86538
10	11808.84	ABC	1.134907	12	0.094576	0.649759
11	11845.86	BC X subj w. groups	104.7994	720	0.145555	
12	11949.83	(error (bc))				

Table 45. ANOVA Summary Tables for Rank (Factor A).

ABC SUMMARY TABLE

	B1				B2				B3				B4				B5			
	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4
A1	134.8	136.6	142.0	186.4	136.1	136.5	136.8	173.4	140.5	147.1	137.5	177.7	133.8	140.8	139.2	166.3	156.3	133.5	142.4	162.0
A2	39.3	40.4	43.2	51.2	38.9	41.6	39.6	51.1	39.4	42.9	39.6	51.1	38.9	40.3	39.0	48.3	45.0	37.6	42.8	47.3
TOTAL	174.1	177.0	185.3	237.5	175.0	178.1	176.4	224.5	179.9	190.0	177.1	228.8	172.8	181.2	178.2	214.7	201.3	171.2	185.2	209.3

AB SUMMARY TABLE

	B1	B2	B3	B4	B5	TOTAL
A1	599.8	582.8	602.8	580.2	594.3	2959.9
A2	174.1	171.1	173.0	166.6	172.7	857.6
TOTAL	774.0	753.9	775.8	746.8	766.9	3817.5

AC SUMMARY TABLE

	C1	C2	C3	C4	TOTAL
A1	701.6	694.6	697.9	865.8	2959.9
A2	201.5	202.9	204.2	248.9	857.6
TOTAL	903.1	897.5	902.1	1114.7	3817.5

BC SUMMARY TABLE

	C1	C2	C3	C4	TOTAL
B1	174.1	177.0	185.3	237.5	774.0
B2	175.0	178.1	176.4	224.5	753.9
B3	179.9	190.0	177.1	228.8	775.8
B4	172.8	181.2	178.2	214.7	746.8
B5	201.3	171.2	185.2	209.3	766.9
TOTAL	903.1	897.5	902.1	1114.7	3817.5

Table 45. ANOVA Summary Tables
for Rank (Factor A) (continued).

B X subj w. G1 SUMMARY TABLE

SUBJ #	B1	B2	B3	B4	B5
1	13.41	11.52	11.16	11.34	13.44
3	10.72	9.87	12.25	10.48	11.53
4	10.44	11.58	10.32	10.42	10.53
6	11.31	11.70	12.90	11.97	12.08
7	14.10	13.74	14.35	13.68	12.17
9	14.29	14.56	13.64	11.77	12.88
10	10.96	11.64	9.80	10.96	10.48
12	11.42	11.08	12.13	11.45	13.12
15	13.87	14.42	12.80	13.50	14.56
16	13.42	11.35	13.42	11.93	12.79
17	10.66	10.75	10.61	10.22	11.86
18	15.06	12.91	14.95	13.77	14.53
19	12.92	12.07	13.41	10.75	11.59
20	10.75	10.87	12.41	11.00	10.47
21	12.66	12.79	12.48	11.80	12.31
22	13.82	10.48	14.07	11.65	12.03
23	13.43	11.34	12.89	11.45	11.95
24	12.13	12.27	12.45	11.34	12.51
25	13.00	12.22	13.32	11.91	12.89
26	12.04	10.73	12.72	11.55	12.25
27	11.38	10.94	12.49	11.31	12.06
28	12.21	11.21	10.88	10.43	11.34
29	13.17	13.61	14.18	13.34	12.24
31	12.51	11.02	12.64	10.51	12.16
32	11.65	10.59	11.56	12.08	12.97
34	12.34	11.13	11.91	13.56	12.08
35	12.71	13.10	14.86	13.88	12.94
36	12.25	12.33	11.53	13.78	12.06
37	13.49	13.02	13.14	11.70	12.70
38	10.87	12.46	12.08	12.76	12.96
39	10.29	11.01	11.13	10.59	10.49
40	12.40	10.84	11.64	10.46	11.02
42	13.19	12.17	12.76	12.76	13.64
43	12.13	11.71	12.78	12.34	12.07
44	12.95	12.94	13.35	13.22	14.20
47	11.92	12.50	12.97	11.77	12.57
49	13.32	13.91	11.63	12.31	11.96
50	12.64	13.19	12.23	13.98	13.30
51	12.20	13.14	12.10	13.07	13.60
52	12.55	14.08	13.49	12.90	12.92
53	13.78	12.38	12.47	11.45	12.26
55	13.82	13.38	12.04	12.87	12.14
56	11.20	11.60	10.82	10.34	11.76
58	14.98	12.71	14.19	13.15	13.12
59	10.99	11.47	12.50	11.60	12.16
60	13.56	13.54	13.86	12.92	13.08
61	12.16	12.36	12.41	13.78	13.23
62	12.76	12.55	13.12	14.45	11.30

C X subj w. G1 SUMMARY TABLE

SUBJ #	C1	C2	C3	C4
1	15.46	14.23	13.98	17.20
3	12.90	13.95	12.21	15.79
4	13.13	12.94	11.87	15.35
6	15.81	13.74	12.95	17.45
7	15.09	17.25	16.34	19.35
9	16.58	14.70	14.87	21.00
10	12.64	12.87	13.60	14.73
12	14.02	14.17	13.43	17.58
15	15.53	16.10	17.24	20.28
16	15.12	14.85	15.08	17.84
17	12.10	12.50	13.08	16.41
18	15.94	17.03	16.73	21.53
19	14.63	14.77	14.04	17.30
20	12.92	13.29	12.77	16.51
21	14.88	14.11	14.23	18.81
22	14.56	16.11	14.33	17.06
23	14.30	14.13	15.29	17.35
24	14.35	14.79	13.96	17.59
25	15.77	14.51	14.12	18.93
26	14.71	13.89	13.29	17.40
27	14.98	13.40	13.15	16.64
28	13.76	13.70	13.53	15.09
29	16.21	14.57	16.02	19.75
31	13.78	14.14	13.22	17.70
32	14.27	12.96	14.56	17.06
34	14.58	14.91	16.04	15.50
35	14.55	16.41	17.40	19.14
36	15.89	14.16	14.44	17.45
37	15.34	13.63	15.86	19.22
38	13.65	13.80	15.30	18.38
39	12.55	11.82	12.95	16.17
40	13.42	13.16	12.45	17.34
42	13.42	16.31	15.34	19.43
43	13.96	15.27	14.53	17.26
44	14.93	15.13	15.53	21.07
47	14.12	15.54	14.19	17.88
49	14.74	13.61	15.60	19.18
50	15.22	14.13	14.56	21.43
51	16.41	14.69	14.74	18.27
52	17.03	14.74	14.46	19.70
53	15.57	14.08	14.46	18.23
55	15.70	14.69	15.95	17.91
56	12.73	13.15	13.28	16.55
58	15.87	16.24	16.54	19.49
59	14.39	13.90	13.66	16.78
60	15.55	15.54	15.74	20.13
61	14.99	15.32	14.98	18.64
62	13.53	15.69	16.00	18.97

Table 45. ANOVA Summary Tables
for Rank (Factor A) (continued).

B X subj w. G2 SUMMARY TABLE

SUBJ #	B1	B2	B3	B4	B5
11	13.27	12.72	12.23	11.50	12.19
13	13.67	12.63	12.16	12.38	12.82
14	12.62	12.88	13.91	11.99	12.81
30	13.19	11.24	12.50	11.80	11.86
33	12.12	12.98	11.90	12.18	11.86
41	11.43	10.29	11.06	11.34	11.22
45	11.74	13.68	13.29	13.18	14.10
46	10.55	10.05	11.07	10.79	10.49
48	12.90	12.76	12.65	11.26	11.72
54	12.10	13.90	11.55	13.10	12.63
57	11.15	11.12	11.92	12.50	11.19

C X subj w. G2 SUMMARY TABLE

SUBJ #	C1	C2	C3	C4
11	12.88	14.40	14.42	20.21
13	16.33	13.91	16.33	17.07
14	15.47	14.52	15.48	18.74
30	15.23	13.93	15.55	15.89
33	14.00	15.83	14.32	16.90
41	13.31	13.53	12.82	15.69
45	15.70	15.31	15.08	19.90
46	12.79	12.41	11.83	15.93
48	13.68	14.84	15.45	17.32
54	14.30	15.22	14.07	19.70
57	14.20	13.33	14.90	15.45

Table 46. Summary of Analysis of Variance for Gender (Factor A).

Known Values		**Source of Variation**	**SS**	**df**	**MS**	**F**
N1= 48		Between Subjects	56.23325	61		
N2= 14		A	0.283737	1	0.283737	0.304279
N= 62		Subj w. groups	55.94952	60	0.932492	
P= 2		(error (a))				
Q= 5						
R= 4		Within subjects	302.9229	1178		
		B	2.597779	4	0.649445	4.676264
Equation Values		AB	1.090061	4	0.272515	1.96222
1	11752.61	B X subj w. groups	33.33147	240	0.138881	
2	12111.76	(error (b))				
3	11752.89					
4	11755.21	C	110.6427	3	36.88089	234.9537
5	11863.25	AC	2.093811	3	0.697937	4.446284
6	11756.58	C X subj w. groups	28.25476	180	0.156971	
7	11865.63	(error (c))				
8	11884.83					
9	11889.38	BC	18.97809	12	1.581508	10.8599
10	11808.84	ABC	1.082019	12	0.090168	0.619168
11	11845.86	BC X subj w. groups	104.8523	720	0.145628	
12	11949.83	(error (bc))				

Table 47. ANOVA Summary Tables for Gender (Factor A).

ABC SUMMARY TABLE

	B1				B2				B3				B4				B5			
	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4
A1	136.1	135.7	142.9	185.1	137.6	136.2	135.3	175.8	136.8	145.4	135.6	176.1	135.0	137.0	137.2	165.5	157.5	131.2	142.7	163.0
A2	38.1	41.4	42.4	52.4	37.4	41.8	41.1	48.7	43.2	44.6	41.5	52.7	37.8	44.1	41.1	49.1	43.8	39.9	42.5	46.3
TOTAL	174.1	177.0	185.3	237.5	175.0	178.1	176.4	224.5	179.9	190.0	177.1	228.8	172.8	181.2	178.2	214.7	201.3	171.2	185.2	209.3

AB SUMMARY TABLE

	B1	B2	B3	B4	B5	TOTAL
A1	599.8	584.9	593.9	574.7	594.3	2947.6
A2	174.2	169.0	181.9	172.1	172.6	869.9
TOTAL	774.0	753.9	775.8	746.8	766.9	3817.5

AC SUMMARY TABLE

	C1	C2	C3	C4	TOTAL
A1	702.9	685.6	693.6	865.5	2947.6
A2	200.2	211.9	208.5	249.2	869.9
TOTAL	903.1	897.5	902.1	1114.7	3817.5

BC SUMMARY TABLE

	C1	C2	C3	C4	TOTAL
B1	174.1	177.0	185.3	237.5	774.0
B2	175.0	178.1	176.4	224.5	753.9
B3	179.9	190.0	177.1	228.8	775.8
B4	172.8	181.2	178.2	214.7	746.8
B5	201.3	171.2	185.2	209.3	766.9
TOTAL	903.1	897.5	902.1	1114.7	3817.5

Table 47. ANOVA Summary Tables
for Gender (Factor A) (continued).

B X subj w. G1 SUMMARY TABLE

SUBJ #	B1	B2	B3	B4	B5
1	13.41	11.52	11.16	11.34	13.44
2	14.28	11.89	13.39	12.64	12.96
3	10.72	9.87	12.25	10.48	11.53
4	10.44	11.58	10.32	10.42	10.53
5	11.79	11.92	12.76	10.58	12.71
6	11.31	11.70	12.90	11.97	12.08
8	13.35	13.05	12.63	11.38	14.08
9	14.29	14.56	13.64	11.77	12.88
10	10.96	11.64	9.80	10.96	10.48
11	13.27	12.72	12.23	11.50	12.19
12	11.42	11.08	12.13	11.45	13.12
13	13.67	12.63	12.16	12.38	12.82
14	12.62	12.88	13.91	11.99	12.81
15	13.87	14.42	12.80	13.50	14.56
17	10.66	10.75	10.61	10.22	11.86
18	15.06	12.91	14.95	13.77	14.53
19	12.92	12.07	13.41	10.75	11.59
21	12.66	12.79	12.48	11.80	12.31
23	13.43	11.34	12.89	11.45	11.95
25	13.00	12.22	13.32	11.91	12.89
27	11.38	10.94	12.49	11.31	12.06
28	12.21	11.21	10.88	10.43	11.34
29	13.17	13.61	14.18	13.34	12.24
30	13.19	11.24	12.50	11.80	11.86
31	12.51	11.02	12.64	10.51	12.16
32	11.65	10.59	11.56	12.08	12.97
36	12.25	12.33	11.53	13.78	12.06
37	13.49	13.02	13.14	11.70	12.70
39	10.29	11.01	11.13	10.59	10.49
40	12.40	10.84	11.64	10.46	11.02
41	11.43	10.29	11.06	11.34	11.22
42	13.19	12.17	12.76	12.76	13.64
45	11.74	13.68	13.29	13.18	14.10
46	10.55	10.05	11.07	10.79	10.49
49	13.32	13.91	11.63	12.31	11.96
50	12.64	13.19	12.23	13.98	13.30
51	12.20	13.14	12.10	13.07	13.60
52	12.55	14.08	13.49	12.90	12.92
53	13.78	12.38	12.47	11.45	12.26
54	12.10	13.90	11.55	13.10	12.63
55	13.82	13.38	12.04	12.87	12.14
56	11.20	11.60	10.82	10.34	11.76
57	11.15	11.12	11.92	12.50	11.19
58	14.98	12.71	14.19	13.15	13.12
59	10.99	11.47	12.50	11.60	12.16
60	13.56	13.54	13.86	12.92	13.08
61	12.16	12.36	12.41	13.78	13.23
62	12.76	12.55	13.12	14.45	11.30

C X subj w. G1 SUMMARY TABLE

SUBJ #	C1	C2	C3	C4
1	15.46	14.23	13.98	17.20
2	14.96	15.97	14.44	19.80
3	12.90	13.95	12.21	15.79
4	13.13	12.94	11.87	15.35
5	14.39	14.51	14.88	15.97
6	15.81	13.74	12.95	17.45
7	14.28	15.19	14.68	20.34
8	16.58	14.70	14.87	21.00
9	12.64	12.87	13.60	14.73
10	12.88	14.40	14.42	20.21
11	14.02	14.17	13.43	17.58
12	16.33	13.91	16.33	17.07
13	15.47	14.52	15.48	18.74
14	15.53	16.10	17.24	20.28
15	12.10	12.50	13.08	16.41
16	15.94	17.03	16.73	21.53
17	14.63	14.77	14.04	17.30
18	14.88	14.11	14.23	18.81
19	14.30	14.13	15.29	17.35
20	15.77	14.51	14.12	18.93
21	14.98	13.40	13.15	16.64
22	13.76	13.70	13.53	15.09
23	16.21	14.57	16.02	19.75
24	15.23	13.93	15.55	15.89
25	13.78	14.14	13.22	17.70
26	14.27	12.96	14.56	17.06
27	15.89	14.16	14.44	17.45
28	15.34	13.63	15.86	19.22
29	12.55	11.82	12.95	16.17
30	13.42	13.16	12.45	17.34
31	13.31	13.53	12.82	15.69
32	13.42	16.31	15.34	19.43
33	15.70	15.31	15.08	19.90
34	12.79	12.41	11.83	15.93
35	14.74	13.61	15.60	19.18
36	15.22	14.13	14.56	21.43
37	16.41	14.69	14.74	18.27
38	17.03	14.74	14.46	19.70
39	15.57	14.08	14.46	18.23
40	14.30	15.22	14.07	19.70
41	15.70	14.69	15.95	17.91
42	12.73	13.15	13.28	16.55
43	14.20	13.33	14.90	15.45
44	15.87	16.24	16.54	19.49
45	14.39	13.90	13.66	16.78
46	15.55	15.54	15.74	20.13
47	14.99	15.32	14.98	18.64
48	13.53	15.69	16.00	18.97

Table 47. ANOVA Summary Tables
for Gender (Factor A) (continued).

B X subj w. G2 SUMMARY TABLE

SUBJ #	B1	B2	B3	B4	B5
7	14.10	13.74	14.35	13.68	12.17
16	13.42	11.35	13.42	11.93	12.79
20	10.75	10.87	12.41	11.00	10.47
22	13.82	10.48	14.07	11.65	12.03
24	12.13	12.27	12.45	11.34	12.51
26	12.04	10.73	12.72	11.55	12.25
33	12.12	12.98	11.90	12.18	11.86
34	12.34	11.13	11.91	13.56	12.08
35	12.71	13.10	14.86	13.88	12.94
38	10.87	12.46	12.08	12.76	12.96
43	12.13	11.71	12.78	12.34	12.07
44	12.95	12.94	13.35	13.22	14.20
47	11.92	12.50	12.97	11.77	12.57
48	12.90	12.76	12.65	11.26	11.72

C X subj w. G2 SUMMARY TABLE

SUBJ #	C1	C2	C3	C4
49	15.0[illegible]	17.25	16.34	19.35
50	15.12	14.85	15.08	17.84
51	12.92	13.29	12.77	16.51
52	14.56	16.11	14.33	17.06
53	14.35	14.79	13.96	17.59
54	14.71	13.89	13.29	17.40
55	14.00	15.83	14.32	16.90
56	14.58	14.91	16.04	15.50
57	14.55	16.41	17.40	19.14
58	13.65	13.80	15.30	18.38
59	13.96	15.27	14.53	17.26
60	14.93	15.13	15.53	21.07
61	14.12	15.54	14.19	17.88
62	13.68	14.84	15.45	17.32

Table 48. Summary of Analysis of Variance
for Educational Level (Factor A).

Known Values	
N1= 27	
N2= 35	
N= 62	
P= 2	
Q= 5	
R= 4	
Equation Values	
1	11752.61
2	12111.76
3	11756.16
4	11755.21
5	11863.25
6	11760.02
7	11868.33
8	11884.83
9	11892.84
10	11808.84
11	11845.86
12	11949.83

Source of Variation	SS	df	MS	F
Between Subjects	56.23325	61		
A	3.550373	1	3.550373	4.043484
Subj w. groups (error (a))	52.68288	60	0.878048	
Within subjects	302.9229	1178		
B	2.597779	4	0.649445	4.700349
AB	1.260853	4	0.315213	2.281352
B X subj w. groups (error (b))	33.16068	240	0.138169	
C	110.6427	3	36.88089	230.314
AC	1.524618	3	0.508206	3.173649
C X subj w. groups (error (c))	28.82395	180	0.160133	
BC	18.97809	12	1.581508	10.9218
ABC	1.676251	12	0.139688	0.964674
BC X subj w. groups (error (bc))	104.258	720	0.144803	

Table 49. ANOVA Summary Tables for Educational Level (Factor A).

ABC SUMMARY TABLE

	B1				B2				B3				B4				B5			
	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4
A1	77.4	77.6	81.7	105.6	74.7	78.7	81.3	95.3	79.5	85.1	80.6	101.4	78.0	82.4	83.4	94.4	88.4	76.6	82.2	90.9
A2	96.7	99.5	103.5	131.9	100.3	99.4	95.1	129.1	100.5	105.0	96.5	127.3	94.8	98.7	94.8	120.2	112.8	94.6	103.0	118.4
TOTAL	174.1	177.0	185.3	237.5	175.0	178.1	176.4	224.5	179.9	190.0	177.1	228.8	172.8	181.2	178.2	214.7	201.3	171.2	185.2	209.3

AB SUMMARY TABLE

	B1	B2	B3	B4	B5	TOTAL
A1	342.4	330.1	346.5	338.3	338.1	1695.4
A2	431.6	423.8	429.3	408.6	428.8	2122.1
TOTAL	774.0	753.9	775.8	746.8	766.9	3817.5

AC SUMMARY TABLE

	C1	C2	C3	C4	TOTAL
A1	398.0	400.3	409.3	487.7	1695.4
A2	505.1	497.2	492.9	627.0	2122.1
TOTAL	903.1	897.5	902.1	1114.7	3817.5

BC SUMMARY TABLE

	C1	C2	C3	C4	TOTAL
B1	174.1	177.0	185.3	237.5	774.0
B2	175.0	178.1	176.4	224.5	753.9
B3	179.9	190.0	177.1	228.8	775.8
B4	172.8	181.2	178.2	214.7	746.8
B5	201.3	171.2	185.2	209.3	766.9
TOTAL	903.1	897.5	902.1	1114.7	3817.5

Table 49. ANOVA Summary Tables
for Educational Level (Factor A) (continued).

B X subj w. G1 SUMMARY TABLE

SUBJ #	B1	B2	B3	B4	B5
2	14.28	11.89	13.39	12.64	12.96
5	11.79	11.92	12.76	10.58	12.71
7	14.10	13.74	14.35	13.68	12.17
10	10.96	11.64	9.80	10.96	10.48
12	11.42	11.08	12.13	11.45	13.12
15	13.87	14.42	12.80	13.50	14.56
16	13.42	11.35	13.42	11.93	12.79
21	12.66	12.79	12.48	11.80	12.31
22	13.82	10.48	14.07	11.65	12.03
29	13.17	13.61	14.18	13.34	12.24
30	13.19	11.24	12.50	11.80	11.86
32	11.65	10.59	11.56	12.08	12.97
34	12.34	11.13	11.91	13.56	12.08
35	12.71	13.10	14.86	13.88	12.94
36	12.25	12.33	11.53	13.78	12.06
37	13.49	13.02	13.14	11.70	12.70
38	10.87	12.46	12.08	12.76	12.96
43	12.13	11.71	12.78	12.34	12.07
44	12.95	12.94	13.35	13.22	14.20
47	11.92	12.50	12.97	11.77	12.57
53	13.78	12.38	12.47	11.45	12.26
57	11.15	11.12	11.92	12.50	11.19
58	14.98	12.71	14.19	13.15	13.12
59	10.99	11.47	12.50	11.60	12.16
60	13.56	13.54	13.86	12.92	13.08
61	12.16	12.36	12.41	13.78	13.23
62	12.76	12.55	13.12	14.45	11.30

C X subj w. G1 SUMMARY TABLE

SUBJ #	C1	C2	C3	C4
2	14.96	15.97	14.44	19.80
5	14.39	14.51	14.88	15.97
7	15.09	17.25	16.34	19.35
10	12.64	12.87	13.60	14.73
12	14.02	14.17	13.43	17.58
15	15.53	16.10	17.24	20.28
16	15.12	14.85	15.08	17.84
21	14.88	14.11	14.23	18.81
22	14.56	16.11	14.33	17.06
29	16.21	14.57	16.02	19.75
30	15.23	13.93	15.55	15.89
32	14.27	12.96	14.56	17.06
34	14.58	14.91	16.04	15.50
35	14.55	16.41	17.40	19.14
36	15.89	14.16	14.44	17.45
37	15.34	13.63	15.86	19.22
38	13.65	13.80	15.30	18.38
43	13.96	15.27	14.53	17.26
44	14.93	15.13	15.53	21.07
47	14.12	15.54	14.19	17.88
53	15.57	14.08	14.46	18.23
57	14.20	13.33	14.90	15.45
58	15.87	16.24	16.54	19.49
59	14.39	13.90	13.66	16.78
60	15.55	15.54	15.74	20.13
61	14.99	15.32	14.98	18.64
62	13.53	15.69	16.00	18.97

Table 49. ANOVA Summary Tables
for Educational Level (Factor A) (continued).

B X subj w. G2 SUMMARY TABLE

SUBJ #	B1	B2	B3	B4	B5
6	11.31	11.70	12.90	11.97	12.08
8	13.35	13.05	12.63	11.38	14.08
9	14.29	14.56	13.64	11.77	12.88
11	13.27	12.72	12.23	11.50	12.19
13	13.67	12.63	12.16	12.38	12.82
14	12.62	12.88	13.91	11.99	12.81
17	10.66	10.75	10.61	10.22	11.86
18	15.06	12.91	14.95	13.77	14.53
19	12.92	12.07	13.41	10.75	11.59
20	10.75	10.87	12.41	11.00	10.47
23	13.43	11.34	12.89	11.45	11.95
24	12.13	12.27	12.45	11.34	12.51
25	13.00	12.22	13.32	11.91	12.89
26	12.04	10.73	12.72	11.55	12.25
27	11.38	10.94	12.49	11.31	12.06
28	12.21	11.21	10.88	10.43	11.34
31	12.51	11.02	12.64	10.51	12.16
33	12.12	12.98	11.90	12.18	11.86
39	10.29	11.01	11.13	10.59	10.49
40	12.40	10.84	11.64	10.46	11.02
41	11.43	10.29	11.06	11.34	11.22
42	13.19	12.17	12.76	12.76	13.64
45	11.74	13.68	13.29	13.18	14.10
46	10.55	10.05	11.07	10.79	10.49
48	12.90	12.76	12.65	11.26	11.72
49	13.32	13.91	11.63	12.31	11.96
50	12.64	13.19	12.23	13.98	13.30
51	12.20	13.14	12.10	13.07	13.60
52	12.55	14.08	13.49	12.90	12.92
54	12.10	13.90	11.55	13.10	12.63
55	13.82	13.38	12.04	12.87	12.14
56	11.20	11.60	10.82	10.34	11.76

C X subj w. G2 SUMMARY TABLE

SUBJ #	C1	C2	C3	C4
6	15.81	13.74	12.95	17.45
8	14.28	15.19	14.68	20.34
9	16.58	14.70	14.87	21.00
11	12.88	14.40	14.42	20.21
13	16.33	13.91	16.33	17.07
14	15.47	14.52	15.48	18.74
17	12.10	12.50	13.08	16.41
18	15.94	17.03	16.73	21.53
19	14.63	14.77	14.04	17.30
20	12.92	13.29	12.77	16.51
23	14.30	14.13	15.29	17.35
24	14.35	14.79	13.96	17.59
25	15.77	14.51	14.12	18.93
26	14.71	13.89	13.29	17.40
27	14.98	13.40	13.15	16.64
28	13.76	13.70	13.53	15.09
31	13.78	14.14	13.22	17.70
33	14.00	15.83	14.32	16.90
39	12.55	11.82	12.95	16.17
40	13.42	13.16	12.45	17.34
41	13.31	13.53	12.82	15.69
42	13.42	16.31	15.34	19.43
45	15.70	15.31	15.08	19.90
46	12.79	12.41	11.83	15.93
48	13.68	14.84	15.45	17.32
49	14.74	13.61	15.60	19.18
50	15.22	14.13	14.56	21.43
51	16.41	14.69	14.74	18.27
52	17.03	14.74	14.46	19.70
54	14.30	15.22	14.07	19.70
55	15.70	14.69	15.95	17.91
56	12.73	13.15	13.28	16.55

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Vita

Captain Anita Eigner Latin was born in Augusta, Georgia on 6 October, 1962. She obtained her B.S degree in Electrical Engineering from the United States Air Force Academy in Colorado in 1984. Immediately after graduation, she was assigned to the 544th Strategic Intelligence Wing (SIW), Electronic Intelligence Squadron, Offutt AFB, NE, where she became a ground-based radar electronic intelligence specialist. In 1988, she was assigned to the Defense Meteorological Satellite Program (DMSP), Los Angeles AFB, CA. The DMSP SPO is responsible for equipping worldwide strategic and tactical forces with capability to receive weather imagery and data from satellites. For two and a half years she worked as the project officer responsible for the S11-S14 (4 satellite) production contract worth over $200M. Once all four satellites were manufactured she transitioned to the Support and Services Launch contract worth over $93M. She became the Program manager of Satellite Integration and Test responsible for conducting launch and early-orbit operations of all satellites and performing anomaly resolution of satellites on-orbit. Captain Latin graduated from the Air Force Institute of Technology (AFIT) Graduate Systems Management Program in September, 1994, and proceeded to the National Aerospace Intelligence Center, at WPAFB, OH.

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Vita

Captain Anthony L. Villanueva was born August 1, 1967 in Muskegon, MI. He graduated from Muskegon Catholic Central High School in 1985. After high school, he attended college at the University of Notre Dame on four year ROTC scholarship. In May of 1989 he graduated with a bachelor of science degree in Aerospace Engineering and received his United States Air Force Commission. In August of that same year he reported to his first duty station, Scott AFB IL. While at Scott AFB he worked as a program manager in the Communications System Program Office for two years before moving to Headquarters Air Force Communications Command in 1991. During the next two years he worked as a Communications-Computer Acquisition Management Staff Officer, and provided headquarters oversight for AFCC's acquisition programs. In May 1993, he was assigned to the Air Force Institute of Technology and began work on his Masters degree in Systems Management.

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13. ABSTRACT *(Maximum 200 words)* The objective of this thesis was to determine whether or not, and by how much, three-dimensional graphs are more accurate and efficient than two-dimensional graphs and tables when presenting alternatives to decision makers. A graphical experiment was designed using a microcomputer. This experiment presented a business scenario to test Air Force Institute of Technology (AFIT) Professional Continuing Education (PCE) students. The experiment attempted to determine how well DoD decision makers accurately and efficiently performed elementary data collection tasks using various graphs or tables. The experiment used a randomized order within-subject factorial design with repeated measures. The factorial experiment was designed to analyze the manipulation of three factors or independent variables, anchoring, mode of presentation, and data-set, to determine their effects on the response variables of degree of accuracy, and response time (efficiency). The results of the accuracy analysis showed that in general, accuracy performance was high for most subjects regardless of the mode of presentation or the task anchoring. The timed response analysis showed that it took subjects longer to interpret three-dimensional line graphs and three-dimensional bar charts for two of the elementary data collection tasks.

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